



COUNCIL OF SUPPLY CHAIN MANAGEMENT PROFESSIONALS

CSCMP

A large container ship is shown from a low angle, sailing on the ocean. The ship's deck is completely covered with stacks of colorful shipping containers in shades of orange, blue, red, green, and yellow. The ship's superstructure, including the bridge and various antennas, is visible at the top. The sky is overcast and grey. The ship's hull is dark grey, and a red tugboat is partially visible in the lower-left corner.

# THE DEFINITIVE GUIDE TO TRANSPORTATION

Principles, Strategies, and Decisions  
for the Effective Flow of Goods  
and Services

Council of Supply Chain Management Professionals and

**Thomas J. Goldsby ■ Deepak Iyengar**  
**Shashank Rao**

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FLOW OF GOODS AND SERVICES

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Management Professionals

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*Tom:*

*To my darling wife Kathie, my two amazing kids Emma and Aiden, my parents Joe and Sujane Goldsby, my brother Mike, my in-laws Doug and Carole Boyd, and great friends, colleagues, and students who motivate and inspire me every day.*

*Deepak:*

*To Advay, the joy of my life, my wife Shilpa, parents Mitra and Jawahar, and in-laws Karabi and Chandrashekar, who make life that much more interesting.*

*Shashank:*

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# TRANSPORTATION IN BUSINESS AND THE ECONOMY

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Transportation is among the more vital economic activities for a business. By moving goods from locations where they are sourced to locations where they are demanded, transportation provides the essential service of linking a company to its suppliers and customers. It is an essential activity in the logistics function, supporting the economic utilities of place and time. *Place utility* infers that customers have product available where they demand it. *Time utility* suggests that customers have access to product when they demand it. By working in close collaboration with inventory planners, transportation professionals seek to ensure that the business has product available *where* and *when* customers seek it.

Transportation is sometimes to blame for a company's inability to properly serve customers. Late deliveries can be the source of service problems and complaints. Products might also incur damage while in transit, or warehouse workers might load the wrong items at a shipping location. Such *over, short, or damaged* (called OS&D) shipments can frustrate customers, too, leading to dissatisfaction and the decision to buy from a competitor for future purchases.

However, when a company performs on time with complete and undamaged deliveries consistently, this can instill customer confidence and gain business for the company. When a company instills confidence in service performance, it can make customers more reluctant to succumb to competitors' bids to steal business away through clever promotions and reduced prices.

Aside from its service ramifications, transportation can also represent a substantial cost for the business. The cost of transportation can sometimes determine whether a customer transaction results in a profit or a loss for the business, depending on the expense incurred in providing transportation for a customer's order. Faster modes of transportation generally cost more than slower modes. So although shipping an order overseas by airplane is much faster than transporting by ship, it can cost as much as 20 times more. Such a cost difference might not justify the use of the faster way of transporting the goods. Supply chain managers must therefore carefully consider the cost of transporting

goods when determining *whether* to move product and *how* to move product in the most economical manner.

This book supports the learning objectives of the Transportation Management module (Learning Block 5) of the Council of Supply Chain Management Professionals (CSCMP) SCPro Level 1 certification. These objectives are stated as follows:

1. Describe the basic concepts of transportation management and its essential role in demand fulfillment.
2. Identify the key elements and processes in managing transportation operations and how they interact.
3. Identify principles and strategies for establishing efficient, effective, and sustainable transportation operations.
4. Explain the critical role of technology in managing transportation operations and product flows.
5. Define the requirements and challenges of planning and moving goods between countries.
6. Discuss how to assess the performance of transportation operations using standard metrics and frameworks.

The book is organized into three sections. Section 1, “Transportation: The Basics,” provides a foundation for transportation operations, including a survey of transportation modes, the economics of transportation, and the array of transportation service providers. Section 2, “Transportation for Managers,” provides a customer’s perspective on transportation, including insights on designing a logistics network, selecting services, and evaluating performance. Content is provided on key aspects of transportation management, including strategy formation, technology deployment, and international supply chain operations. Section 3, “Transportation in 2013 and Beyond,” is dedicated to contemporary issues in logistics, including sustainability, and offers an outlook on the future of transportation. Throughout the text, we feature important terms and concepts that are essential for supply chain professionals who are responsible for transportation activity to understand. In this first chapter, we continue by illustrating the role of transportation in the logistics function, the supply chain, and the larger economy.

## Transportation and Logistics

*Logistics* is defined as “that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information from the point of origin to the point of consumption in order

to meet customers' requirements."<sup>1</sup> Transportation is represented in this expression through the word *flow*. Transportation provides the flow of inventory from points of origin in the supply chain to destinations, or points of use and consumption. Most businesses manage both inbound and outbound logistics. Inbound logistics involves the procurement of materials and goods from supplier locations. Outbound logistics involves the distribution of materials and goods to customer locations. Therefore, transportation is necessary on the inbound and outbound sides of the business.

The definition of *logistics* mentions not only the forward flow and storage of goods, services, and related information, but also the reverse flow.

Inventory sometimes flows in the reverse direction. *Reverse logistics* refers to "the role of logistics in product returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal, and refurbishing, repair, and remanufacturing."<sup>2</sup> So transportation not only delivers material and products to customers, but also moves reusable and recyclable content to companies that can use it. Figure 1-1 shows the forward and reverse flows managed by logistics.

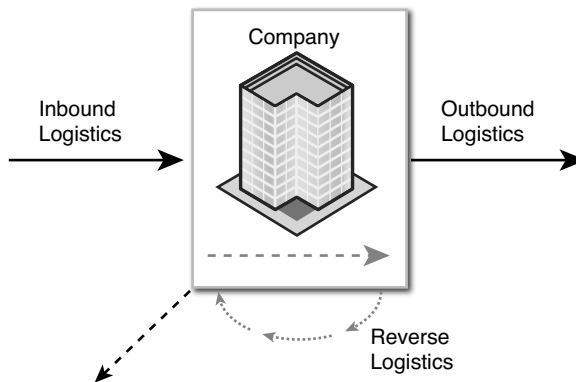


Figure 1-1 Forward and reverse flows in logistics.

Transportation is only one activity responsible for providing time and place utilities through inbound and outbound logistics. Logistics also involves forecasting demand, planning inventory, and storing goods as well as delivering them. Optimized logistics performance means that these activities are working closely together so that the customer of the logistics service is satisfied with the service, yet the cost the company incurs is minimized. This optimal performance requires an understanding of how the various logistical decisions and actions affect service for customers and total cost.

Consider, for instance, that a company seeks to minimize its investment in inventory. The company elects to hold all its inventory in one central warehouse location, for it has been shown that consolidated inventory reduces inventory investment. Warehousing

cost should also be minimized because the company is maintaining only a single facility instead of several locations. Customers located close to the central warehouse will be pleased with this decision because the company must travel only a short distance to deliver items to these nearby customers. However, customers located farther from the central warehouse are likely to be disappointed. They will ask for faster transportation to reduce the order lead times. This might involve using faster means of transporting the goods, which, as noted, tends to cost more than using slower modes. In sum, holding inventory in one central location might reduce inventory and warehousing costs, but it will increase transportation costs. The business might also be at risk of losing sales to competitors who can offer shorter and more reliable order lead times.

Conversely, a supply chain strategy that seeks to minimize transportation cost will likely not represent an optimal solution for the company. This might call for shipping orders to customers in large volumes and using slow means of transportation. Requiring large order quantities and using slow forms of transport are two more ways to disappoint customers and risk losing business to competitors. So although transportation is usually a sizeable expense for a company, and often the largest expense in the function of logistics, supply chain managers must consider the interrelationships among the various logistical actions and costs. Tradeoffs are often associated with these decisions, and the company's customers are also affected. The recognition of interrelationships among transportation, inventory, warehousing, information exchange, and customer service is the embodiment of a *systems approach*.<sup>3</sup> The manager seeks to optimize the performance of the logistics system instead of optimizing a singular element of the system. This book, therefore, treats transportation as one important element of the logistics system.

## Transportation and the Supply Chain

Another system that calls for recognizing tradeoffs and interrelationships among actions and costs is the supply chain. A *supply chain* is the network of companies that work together to provide a good or service for end users and consumers. Most companies operate within supply chains, relying on outside parties such as suppliers and customers to help them reach the end-user market.<sup>4</sup> In other words, most companies do not entirely own their supply chains.<sup>5</sup>

Supply chain management encompasses the planning and management of all activities involved in sourcing, procurement, conversion, and logistics management. It also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, or customers. Supply chain management integrates supply-and-demand management within and across companies.<sup>6</sup> Managing a supply chain, then, means managing the business relationships among the focal company and its outside supply chain partners, including customers and suppliers.<sup>7</sup>

As Figure 1-2 illustrates, transportation represents the physical connection among the companies in the supply chain. The locations in a supply chain network are called *nodes*, and the connections are referred to as *links*. When one entity sells product to another, transportation provides the delivery. An outbound delivery for a supplying company is the inbound delivery for its customer. When one level in the supply chain experiences delays and problems, it impacts the abilities of downstream members of the supply chain to serve their customers. For this reason, the larger economy is affected when transportation disruptions occur. Potential sources for disruptions include equipment failures, natural disasters and inclement weather, work stoppages, and government intervention. The next section reviews the role of transportation in the larger economy.

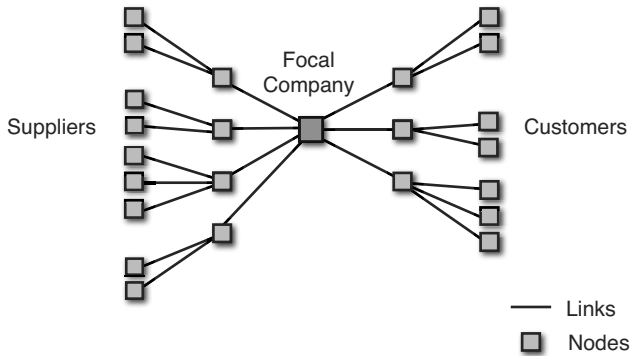


Figure 1-2 Links and nodes in a supply chain.

## Transportation and the Economy

The business of moving freight is a major expense for an individual company and is essential for flowing product through the supply chain. In total, transportation is a significant industry in every developed economy. Each year, the CSCMP conducts an analysis of logistics costs in the United States. Table 1-1 illustrates the expenditures directed toward various logistics activities in the United States in 2012. Of the \$1.331 trillion sum, \$836 billion (or 62.8 percent of total logistics cost) was spent on transportation. This amount greatly exceeds the expenses dedicated to other logistics activities. Logistics costs amount to 8.5 percent of the nation's gross domestic product (GDP), and transportation alone represents 5.4 percent of the U.S. GDP. In other words, just over 5 cents of every dollar spent in the United States goes toward transportation. Total logistics costs in Europe run the range of 12 percent. In less developed countries, the share of the GDP directed toward transportation can be even greater because it costs more to move

products when infrastructure is lacking or not sufficiently maintained. Total logistics costs in China are approximately 21 percent of the GDP.

**Table 1-1 U.S. Logistics Cost, 2012**

<b>Cost Category</b>	<b>\$ Billions</b>	<b>% of Total</b>
Inventory-Carrying Cost	305	22.9
Transportation	836	62.8
Warehousing	130	9.8
Shipper-Related Costs	10	0.8
Logistics Administration	51	3.8
<b>Total Logistics Cost</b>	<b>1,331</b>	<b>100</b>

Source: Rosalyn Wilson (2013), *The 24th Annual State of Logistics Report: Is This the New Normal?* CSCMP.

The ease or difficulty with which companies can transport goods within a country can affect their competitiveness in global trade. When transporting goods is easy and costs are relatively low, exporters can efficiently ship their merchandise to export locations and on to international markets. One such example is that of U.S. farmers in the central states of Illinois, Indiana, Iowa, Nebraska, and Ohio. Farmers in these states compete with farmers in the Pampas region of Argentina to sell grains, such as corn and soybeans, in markets abroad. The growing conditions in Argentina are considered advantageous to those in the United States, allowing farmers to achieve greater yields and enjoy lower costs of production. However, by virtue of using the highly efficient U.S. railroads and river barges to reach the export port, the American farmer enjoys savings in transit time and transportation expense that can offset the inherent advantages in production yield and costs enjoyed by the Argentinian farmer. The more difficult it is to move product over a distance, the greater the *friction of distance*. With greater friction come higher costs. In the grain-shipping example, the farmer in Argentina faces greater friction of distance (and higher costs) in transporting the grains from the farm to the export port in Buenos Aires. Despite the longer distance, there is less friction for the American farmer, who can efficiently ship the grains via railroad and barge.

Table 1-2 contains statistics of the transportation infrastructure in the United States. With more than 4 million miles of public roadways, enough to circle the globe 157 times, virtually every business and household in the nation enjoys the benefits of easy roadway access. The Interstate Highway System (originally called the National System of Interstate and Defense Highways) provides efficient connectivity among almost every large and medium-size city in the nation. High-speed delivery is supported with a network of more than 5,000 public airports, as well as another 14,339 for private use and 271 for military purposes. Freight rail transportation occurs over 161,000 miles, most of which is operated by major Class I rail operators. The continental United States is also endowed

with various forms of navigable waterways, including rivers, Great Lakes, and ocean shipping on three coasts. Finally, pipelines, an often overlooked mode of transportation, distribute large quantities of fluid material (gas and liquids) over long distances throughout the nation. In sum, this extensive network of transportation assets supports commerce among businesses and consumers within the United States, and also helps to support export and import activity with businesses abroad.

**Table 1-2 U.S. Transportation Infrastructure**

Miles of Public Roadways	4,059,339
Miles of Interstate Highway System	47,011
Miles of National Highway System	117,084
Miles, Other Roads	3,895,244
Number of Public Airports	5,172
Miles of Railroad	161,195
Miles of Navigable Waterways	25,320
Number of Commercial Ocean Facilities	5,588
Miles of Pipelines	1,735,237
Miles, Hazardous Liquid Pipelines	177,631
Miles, Gas Transmission and Gathering	324,606
Miles, Gas Distribution	1,233,000

Source: These data are presented in the *2013 Pocket Guide to Transportation*, Bureau of Transportation Statistics, U.S. Department of Transportation, compiled from various sources.

A strong argument can be made that the economic health of a nation is linked to the health of its transportation infrastructure. This argument works in two ways. First, an extensive infrastructure supports economic growth. Second, economic strength supports investment in infrastructure. A modern case study that illustrates the strong association between infrastructure development and economic growth is that of China during the past two decades.

Transportation supports an economy not only by connecting people and places, but also through the many people it employs. Table 1-3 presents employment data for the United States in 2011. Nearly 4.3 million people were employed in the provision of for-hire transportation services, with almost 1.3 million in the trucking industry alone. Another 5.4 million were employed in transportation-related services and construction. Finally, almost 1.7 million people were employed in the production of transportation equipment in the United States. Combined, this totals 11.4 million transportation-related private sector jobs, or almost 9 percent of the total U.S. labor force.

**Table 1-3 U.S. Transportation-Related Employment, 2011**

For-hire transport and warehousing	4,292
Air	456
Water	63
Railroad	229
Transit/Ground Passenger Transportation	436
Pipeline	43
Trucking	1,299
Support Activities	564
Scenic/Sightseeing Transportation	29
Couriers/Messengers	529
Warehousing/Storage	646
Related Services and Construction	5,405
Transportation-Related Manufacturing	1,684

Source: *2013 Pocket Guide to Transportation*, Research and Innovative Technology Administration, Bureau of Transportation Statistics, U.S. Department of Transportation, Washington, D.C.

Transportation and logistics are regarded as “derived market” activities. That is, demand for transportation and logistics service is derived from the demand of other goods and services in the economy. When a manufacturer seeks supplies from distant locations, there is demand for transportation. Similarly, when consumers have demand for goods produced elsewhere, transportation is demanded. So demand for transportation tends to closely follow the economic activity in a region. For this reason, economists and market analysts pay close attention to transportation shipment data—they present an accurate, timely picture of economic vitality for a region or nation. Rail and trucking volume reflect the economic activity of a nation, and ocean and air transportation statistics illustrate trade levels among nations.

## Transportation, Society, and the Environment

Thus far, we have explored the many ways in which transportation contributes to the economic health of individuals, businesses, and entire nations, by facilitating the flow of commerce and providing employment opportunities. Transportation can impact our lives in other profound ways, however. In some ways, it can be lifesaving; in others, it is damaging. In this section, we explore some of the different ways transportation affects society and our physical environment.

In the case of emergency situations and calls for humanitarian relief, transportation is essential to supporting lifesaving missions. Such is the case following a natural disaster.



When earthquakes, hurricanes, floods, or other events imperil a region, the ability to deliver supplies of water, medical equipment, communication equipment, and energy is most pressing. In recent years, relief organizations have adopted advanced transportation methods to support the ability to deploy crucial resources to those in need whenever and wherever a crisis arises.

Transportation also plays a critical role in the success of military endeavors, dating back to the days of Thutmose III and his storied conquests in the fifteenth century B.C. that transformed Egypt into a “superpower.” The same assertion holds true today. The timely deployment of soldiers, armaments, and supplies has often been credited with the success or failure of military campaigns and peacekeeping missions. A considerable share of the budget for any substantial military body is the provision of transporting soldiers and supplies.

Transportation activity also results in many unintended consequences on society. It is one activity that interfaces directly with people in their day-to-day lives. Manufacturing, another major economic activity, occurs within the confines of buildings. Transportation, on the other hand, involves roadways that passenger vehicles share. More than 32,000 fatalities and 2.2 million injuries occurred on U.S. highways in 2011, with about 1 in 10 fatalities attributed to collisions involving large trucks.<sup>8</sup> Fortunately, these numbers represent steady declines over the past several decades. The declines can be attributed to immense safety improvements in passenger vehicles, increased use of safety belts, and fewer incidents involving alcohol. Sharing the roads with 80,000-pound tractor-trailers and crossing railroad grades remain hazardous though.

Transportation is also the biggest consumer of energy resources in our economy, easily outpacing manufacturing and consumer household usage. According to the Department of Energy, the U.S. transportation system consumes more than 13 million barrels of petroleum each day. This also leads to transportation’s regrettable role as the largest contributor to greenhouse gases. Transportation is responsible for emitting nearly 2 billion metric tons of carbon dioxide in the United States each year. Growing concerns of sustainability are changing the way many companies elect to ship products and also the operations of the transportation providers themselves. The carbon footprint for a shipment, an estimate of the greenhouse gases emitted, has become a critical measure of transportation performance, alongside transit time and cost. Consumers are demanding sustainable products and cleaner ways of transporting them. Since 2009, UPS has offered a carbon-neutral service: The shipping company offsets the carbon emissions associated with package delivery by investing in carbon-reduction projects around the world.

Finally, in light of its central role in economic activity, transportation is also a common target for terrorist activity. Whether one considers the hijacking of passenger airlines on September 11, 2001; the disruption of pipelines in oil-producing countries; the use of vehicle-borne improvised explosive devices (VBIEDs) or “car bombs”; or the hijacking

of ships off the coast of Africa, transportation assets can be particularly difficult to secure and, thereby, vulnerable to attack. The formation of the Transportation Security Administration (TSA) immediately following the terrorist attacks of September 2001 serves as testament to the intense focus placed on security and safety in transportation activity. To date, much focus has been directed to passenger safety, although freight transportation has seen greater regulation and scrutiny of shipments. This trend is expected to continue into the future.

## Summary

These final observations illustrate the many and diverse ways that transportation impacts our lives. Transportation is a major contributor to the economy and a competitive force in business. It is the activity that physically connects the business to its supply chain partners, such as suppliers and customers. Furthermore, the service rendered through transportation activity is a major influence on the customer's satisfaction with the company.

### Key takeaways from this chapter include:

- Transportation helps to fulfill the economic utilities of place and time.
- The cost and service aspects of transportation decisions must be balanced with the inputs of inventory, warehousing, order processing, information, and customer service policies to serve customers at the lowest possible cost.
- Transportation provides the links that connect nodes in the supply chain network, linking a focal company to its suppliers and customers.
- Transportation is a major contributor to economic prosperity for a nation. The more efficient the transportation system, the easier it is to conduct commerce.
- Although transportation is an essential activity in any economy, it presents several hazards to society, including risks of accidental injury and death, greenhouse gas emissions, environmental impact, and terrorist activity.

## Endnotes

1. Definition offered by the CSCMP.
2. James R. Stock (1998), *Development and Implementation of Reverse Logistics Programs*, Council of Logistics Management (CLM), Oak Brook, IL.
3. For a complete treatment of the total cost of logistics and the tradeoffs among logistics activities and costs, see: Douglas M. Lambert, James F. Robeson, and

James R. Stock (1978), “An Appraisal of the Integrated Physical Distribution Management Concept,” *International Journal of Physical Distribution & Logistics Management* 9 (no. 1): 74–88.

4. An end user might be a consumer, business, government entity, or nonprofit organization. It represents the person or organization at the end of the supply chain who will put the supply chain’s product or service to use.
5. Exceptions to this observation do exist. Very large oil and gas companies, for instance, often own the sources of supply, the processing of crude into refined oil and gasoline, and the distribution channels of retail refueling stations.
6. Definition offered by the CSCMP.
7. Martha C. Cooper, Douglas M. Lambert, and Janus D. Pagh (1997), “Supply Chain Management: More Than a New Name for Logistics,” *International Journal of Logistics Management* 8 (no. 1): 1–14.
8. *2013 Pocket Guide to Transportation*, Research and Innovative Technology Administration, Bureau of Transportation Statistics, U.S. Department of Transportation, Washington, D.C.

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