

Chapter 2

Supply Chain Management

Supply Chain Management is a matter of vital importance to the company – the road to survival or ruin for the company. It is mandatory that it be thoroughly studied.⁵

As a result of the panic buying of 2020, everyone now thinks they know what a supply chain is, and the issues associated with supply chains – primarily based on the biased reporting of many “news” reports.

Prior to the COVID-19 crisis/pandemic of 2020 few people talked about supply chain management outside of the supply chain profession. After the panic buying and then the resultant shortages coupled with the excesses of agricultural products due to industry shutdowns, primarily the schools, entertainment, food service, travel and amusement park industries, all of a sudden everyone was talking about supply chain management and pointing at the supply chain as the reason for the shortages. It is always easy to blame someone or something for issues. The goal of this chapter is to provide insights into what a supply chain is and how it impacts daily life.

⁵ A editorial change to the words of Sun Tzu in the opening verses of *The Art of War*

The issues associated with the supply chain and the COVID-19 panic buying clearly demonstrate the line I used to use with my Soldiers when I was in the Army: “Supply chains are invisible as long as everything works right. No one cares about the supply chain until something goes wrong.”

The APICS Operations Body of Knowledge states, “In the simplest terms, supply chain management is balancing or synchronizing supply with demand.”⁶ The Supply Chain Council (a part of the Association for Supply Chain Management) describes the activities of the supply chain as going from the suppliers’ suppliers to the customers’ customers. In other words, the activities of sourcing raw materials, sourcing components, delivering the materials or components to a factory and once the products are made, the delivery of the products to the ultimate final customer. It also includes, as we will see in Chapter 13, getting the products back from the customer and replaced, repaired, or disposed of.

The APICS Dictionary defines supply chain management as: “The global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution, and cash.”⁷ This definition is one of the better definitions of the overall supply chain because it hits on a key aspect that is overlooked by most supply chain definitions—cash flow. I don’t care how good your supply chain design is, if you cannot get the

⁶ APICS Operations Management Body of Knowledge, 2nd edition, APICS, 2009, p. 21.

⁷ APICS Dictionary, 13th edition.

cash from the customer in time to pay your suppliers and other creditors, you will not be in business very long. And you have to get the product to the customer in order to expect payment for those products.

After the attacks of 9/11/2001, there were several Anthrax laced letters delivered to politicians and other public officials. After the Anthrax scare in Washington, DC, in 2001, the US Postal Service location that received and processed one of the tainted letters was closed. The trickle-down problem from this closure was not discovered for about six months. It appears that the electric company that serves the District of Columbia had the payments for its services sent to a Post Office box in this closed down Post Office. About six months after the Post Office was closed, the electric company was trying to determine why it was losing money. The resultant research revealed that even though the Post Office building was closed to customers, apparently the mail was still being delivered there and the electric company's customers' payments were all at the closed facility.

Cash-to-Cash Cycle time is critical to supply chain success. This is a measure of how long after you receive payment for the products you sell that you pay your suppliers. In some cases it may be a positive cycle time which means your company is paying for the products before you receive them and sell them to the customer. If the Cash-to-Cash Cycle time is negative, it means that the suppliers are paid after your company is paid by your customers. At one point when Dell Computers was still in the Assemble to Order model in Texas, they had a negative 35-day Cash-to-Cash Cycle time—in other words, Dell was paying their suppliers on average 35 days after their customers paid Dell for their new computer.

Most textbooks tell us that the term supply chain management first appeared in *The Financial Times* about 1989. However, the term was first used in a series of papers published in the United Kingdom in 1982 by R.K. Oliver and M.D. Webber to describe the future of logistics and transportation. However, these papers remained internal to Booz Allen (the consulting firm was known as Booz Allen Hamilton at the time). It was not until a book was edited by Martin Christopher in 1992 that the public was able to read the papers that predicted that the new concept that Oliver and Webber called supply chain management would be the future of industry. Prior to this point the components that are now considered part of the supply chain management umbrella were stovepipe managed functions that reduced the efficiency of the overall system. By the late 1990s almost every company had adopted the concept of supply chain management.

By the mid-1990s everyone was wondering what this supply chain thing looked like and how to define what a supply chain was. In 1995, the Supply Chain Council⁸ was formed as a partnership between commercial companies and major consulting firms to establish standards for this new corporate function. The Supply Chain Council developed the Supply Chain Operations Reference Model (SCOR) to describe the supply chain. The SCOR model is designed to provide a cross-industry standard for supply chain operations and metrics to improve and benchmark supply chain operations regardless of the industry.

⁸ The Supply Chain Council was merged into APICS (now ASCM) in 2015.

The SCOR model depicts six basic functions that the Council deemed to be inherent to every supply chain. The original model contained four functions—Plan, Source, Make, and Deliver. With Version 9.0 of the model a fifth critical function was added—Return. This version of the Supply Chain Council model appears in Figure 2.1. In 2013, version 11.0 of the SCOR model added the function of Enable. The Enable functions includes all those activities that help to enable the supply chain activities. 2017 saw the release of version 12.0 of the SCOR. Each new version adds additional metrics, benchmarks and best practices to help better manage and measure supply chain management activities.

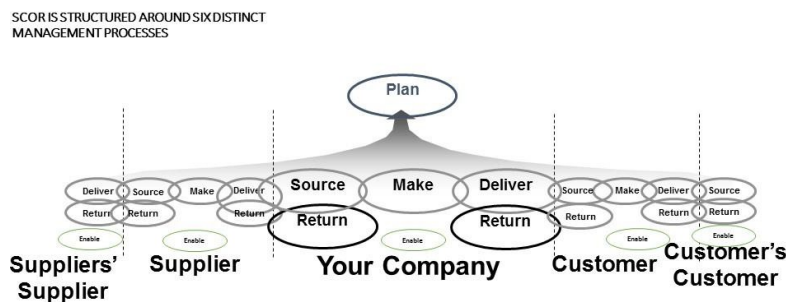


Figure 2.1: Supply Chain Operations Reference Model (reference: ASCM)

Why Is Supply Chain Management Important to Operations Management?

Supply chain expenses account for the majority of the expenses of a company. From a customer perspective, the supply chain may be all the customer sees of the company outside of

the Web site. The late Peter Drucker, a management guru of the twentieth century, wrote in 1982 that logistics and distribution was most likely the last frontier for cost reductions in business. According to most studies, the rule of thumb for most companies is that it takes approximately twelve dollars in increased sales to equal the same value from saving one dollar in the supply chain operations.

The ability to successfully operate supply chain functions is closely watched by Wall Street. The inability to distribute goods to the customer is very closely watched by financial analysts. In 1999, Hershey's had a problem delivering chocolate products to customers during the Halloween season, significantly impacting their stock price and earning them a place on the *Supply Chain Digest's* "Top Supply Chain Disasters of All Time." Toys R Us experienced similar supply chain problems with the delivery of toys for Christmas in 1999.⁹ Like Hershey's, this inability to meet customer due dates impacted their stock price and also earned them a place on the *Supply Chain Digest* list of disasters. In order to achieve supply chain excellence, it is important to carefully plan (part of the SCOR model) the synchronization of all supply chain functions to help the company achieve a competitive advantage. Lowe's firmly believes that their supply chain operations provide them with a competitive advantage over their competition. Apparently, their competition believed so also. In late 2009, The Home Depot announced a

⁹ Toys R US outsourced their online sales distribution to a rather new company after this debacle. They outsourced to Amazon. Amazingly, when Toys R Us closed their doors in 2018, one of the reasons cited was the impact on their sales from Amazon.com. The biggest issue was their inability to pay their suppliers for delivered products

major revamping of their supply chain operations in order to become more competitive. By 2016, this program had once again elevated The Home Depot to the top of the home improvement store ladder. The synchronization of activities and functions has to link the flow of information, the flow of materials, and the flow of cash in order to achieve a competitive advantage.

With the panic buying of 2020, the supply chain has become front page news. Everyone now wants to talk about supply chain management and its ability or inability to support customers.

Supply Chain Information and Supply Chain Uncertainty

The globalization of supply chains is one of the themes of Milton Friedman's best seller, *The World Is Flat*. Friedman makes a good case for the flattening of the globe through the Internet and supply chain globalization. He concludes that the outsourcing and off-shoring of operations is what has leveled the playing field for all companies. As companies continue to globalize the supply chain operations of sourcing, making, and delivering of products (Source, Make, and Deliver from the SCOR Model), there are inherent risks that accompany the complexity of global operations. The risks will be addressed in the discussions and chapter on Supply Chain Security and Preparedness. Along with these risks are the inherent complexities of global operations.

Supply chain risks include forecasting and information flows. We will look at forecasting in greater detail in another chapter. The longer the supply chain is extended globally, the more fluctuations, uncertainty and information flows can impact the overall forecasts. At the same time, the more extended the supply chain is, the chances for distortion of information along

the supply chain becomes the greater. As we will see in later discussions of inventory management, this distortion of information is known as the Bull Whip Effect.

Other uncertainties in the supply chain come from customer ordering patterns. With the advent of the Internet, customers can order from the store or from the Internet sites of the suppliers. Along with this comes the batching of orders by brick and mortar retailers rather than placing an order every time a customer places an order. The result is that suppliers get batched orders from retailers and individual orders from their corporate Web sites. The ordering patterns of the customers, coupled with the batched orders of the retailers, impact the ability of the suppliers to accurately forecast demand patterns. The result is the need to carry insurance in the form of inventory.

The flow of information in the supply chain will help to reduce some or all of the uncertainties associated with supply chains. As supply chains have become more complex and global, the need to pass information digitally and capture information digitally has become more important. Coupled with this increased reliance on information systems is a need to protect the cyber systems and information.

Today's supply chains require a centralized and coordinated information system. World class communications is critical for supply chain success. FedEx has a world class communications system that allows it to track each package, every plane, and every truck. They also have the through their Digitally Assisted Dispatch System to communicate with every driver. BNSF railroad has a similar system to monitor the movement of every train in their system and communicate with the trains while in motion.

A world class supply chain communications system is critical for supply chain management success. Such a system enables companies to integrate their distribution management system, inventory management system, and inbound transportation systems with the production management systems and warehouse management systems. Because so many systems are necessary for a successful supply chain, the lines between Supply Chain Management and Execution Systems and Enterprise Resource Planning Programs have become blurred over the past decade. The supply chain information systems must provide visibility throughout the entire supply chain and provide the customer the ability to track the item through the delivery end of the supply chain once an order has been placed. Sometimes the tracking process is not accurate or does not provide detailed information as seen in Figure 2.2 and Figure 2.3.



Figure 2.2 Status Update from USPS



Figure 2.3 Amazon Status Update

Radio Frequency Identification Tags are one method of tracking items in the supply chain and the use of Bar Codes allows UPS and FedEx to track every single package and parcel shipped and provides the customers the status of their respective packages.

Information within the supply chain may be passed in the form of **Electronic Data Interchange (EDI)**. The APICS Operations Management Body of Knowledge provides the following additional information on Electronic Data Interchange: “EDI is a way for a business to communicate with customers and suppliers. In North America, various industry groups establish and publish standards for standard transaction sets.”¹⁰ EDI is “the electronic communication of business transactions, such as orders, confirmations and invoices, between organizations. Third parties provide EDI services that enable organizations with different equipment to connect.

¹⁰ The APICS Operations Management Body of Knowledge: Electronic Data Interchange

Although interactive access may be a part of it, EDI implies direct computer-to-computer transactions into vendors' databases and ordering systems.”¹¹ Prior to the advent of the Internet, EDI was transmitted via private networks and in set formats. The order forms used for online ordering put the transaction information into a set EDI format for use by the company.

Wal-Mart uses their information system to pass supply chain information through their networks and to their suppliers. Wal-Mart’s information system is so sophisticated that they are linked to the Center for Disease Control in Atlanta, Georgia to pass information on pharmaceutical related sales and issues.¹² Wal-Mart is able to use the point of sale data at the stores to pass information to its headquarters at Bentonville, Arkansas, and from there to Wal-Mart suppliers to help reduce the friction and bullwhip effect in their supply chains. This allows Wal-Mart to consolidate sales data from all the stores into one order to the suppliers. At the same time it allows Wal-Mart to pass the information to their suppliers as soon as a product is sold to assist the suppliers in preparing for the next resupply activity.

¹¹ Electronic Data Interchange, <http://www.answers.com/topic/electronic-data-interchange>, accessed August 16, 2010.

¹² This makes one wonder what the CDC was doing with all of the information that Walmart was passing to them in February and early March 2020 concerning the sales of Lysol, Clorox, disinfecting wipes, toilet paper and other cleaning products. If the CDC was monitoring this information, maybe the warnings would have changed from “nothing to worry about” to “something to be concerned about” a little sooner.

The Bull Whip Effect

The bullwhip effect gets its name from the fluctuations evident in the movement of a bullwhip. You may have seen this type of whip used in some of the old cowboy movies. Basically, a bullwhip is about eight to ten feet long, made from braided strips of leather with a short (about 8-12 inches) wooden handle (think Indiana Jones). A small movement at the handle causes huge fluctuations of the end of the whip. An example of a bullwhip can be seen in Figure 2.4. This analogy is applied to the supply chain where small movements in customer demand at one end of the supply chain leads to huge fluctuations at the other end of the supply chain. The better the flow of information in the supply chain, the less distortion or fluctuations in the information flow results in less inventory in the system to cover the huge fluctuations previously seen in the supply chain.

The mantra in supply chain management in the late 1990s and early 2000s was “replace inventory with information.” At first glance this seemed strange – “I can sell inventory, but I can’t sell information.” What was really being said here was that if we could get a handle on the distortion of information, we could reduce the inventory needed to cover the fluctuations and prevent stockouts.



Figure 2.4: A Bull Whip

Another critical use of information in the supply chain is to keep accurate information on the levels of inventories in the supply room or distribution center. A good information management system will update the inventory availability and inventory levels with every transaction. Why is this important?

Here is scenario that will help to make this aspect clearer. I recently purchased an item from a company's website. The company confirmed the order and even provided shipping status for the product. The day the product was supposed to arrive: "Thank you for your order. We are so sorry we are out of stock of the Item 7422. We issued a credit for them." If their system automatically updated their inventory levels, the initial order would not have been possible. This leaves you wondering, 1. How did this happen? And 2. How can you provide shipping status for a product that is out of stock?

If the inventory management system updates the balance and availability with each transaction the customer will know for sure that the item ordered is available. However, if the inventory management system does a batch update or in some cases a daily update, the items may have been sold and the inventory depleted before the update occurs. In this incident, the customer will receive the confirmation screen only to receive a message the next day that the item is not in stock and will be back ordered and shipped at a later date if the customer does not cancel the item.

Supply Chain Information and Electronic Commerce

With the dependence on supply chain information management systems and more and more companies moving from a strictly “brick and mortar” company to a hybrid company with both “brick and mortar” and e-commerce capabilities the dependence on a quality supply chain management information system is even more critical.

Karl von Clausewitz wrote about military theory in the early 1800s. His work, *On War*, is mandatory reading in most advanced military schools. From a commercial industry perspective, one of the things that Clausewitz said, all things change when you go from the abstract to the concrete, simply means that academic theory does not always work in the real world. Some of the theoretical advantages of electronic commerce from a supply chain perspective sound great in theory, however they do not sound as good when we move from the abstract to the concrete.

- Theoretically, the information systems available coupled with globalized supply chains connected via the Internet should provide companies with reduced prices and costs. The reduction in prices should come from the ability to increase competition for the raw

materials and products as more suppliers become available via the Internet. The theoretical reduction in costs should come about as a result of the reduction in travel expenses and the ability to outsource manufacturing to developing companies. These theoretical cost decreases could be passed on to the consumer or retained as profits for the company. Additional cost reductions should come about as a result of automating previously manual systems and processes.

- Savings from automating manual processes assumes that the manual processes were actually necessary. If the processes are not needed under the automated system, there will not be any savings to the supply chain. All too often when automated systems are put into place, there is not a good analysis of left of baseline and right of baseline requirements resulting in unnecessary automated processes.¹³

Savings from automation also assume that the proper system is implemented. If the new Enterprise Resource Planning program does not improve the overall supply chain operations of

¹³ For every conversion from manual to automated processes a detailed analysis is required of all the processes. The first step is to determine if the processes are value added and needed under the system (known as a left of baseline analysis). After non-value-added processes are eliminated, a test run is necessary before going “live” and then a detailed analysis of the new automated system to make sure everything worked as planned and is a necessary step in the process (known as the left of baseline analysis). When the US Army went to a more modern automated supply chain system in the mid-1990s, a careful analysis of the processes and a process walk determined that some of the processes that were included in the automated systems were outdated and not needed with the new system. This required an Engineering Change Package to update the new system without the unnecessary processes.

the company, then there will be no cost savings. For example, Digital Equipment Company spent approximately \$35 million on an ERP system only to find out that the new system was not as good as the old system.

- Electronic commerce has enabled supply chain companies to shorten order cycle times by enabling customers to place orders online. Prior to this the only options for ordering items from a company was to order from the catalog, order and pick up at the retail facility, or place the order at the distribution center or factory. Supply chain information systems shorten this ordering process thus shortening the entire customer order cycle time. Reducing the customer order cycle time produces more satisfied customers, thus producing more commerce.

Bar Codes and RFID Tags

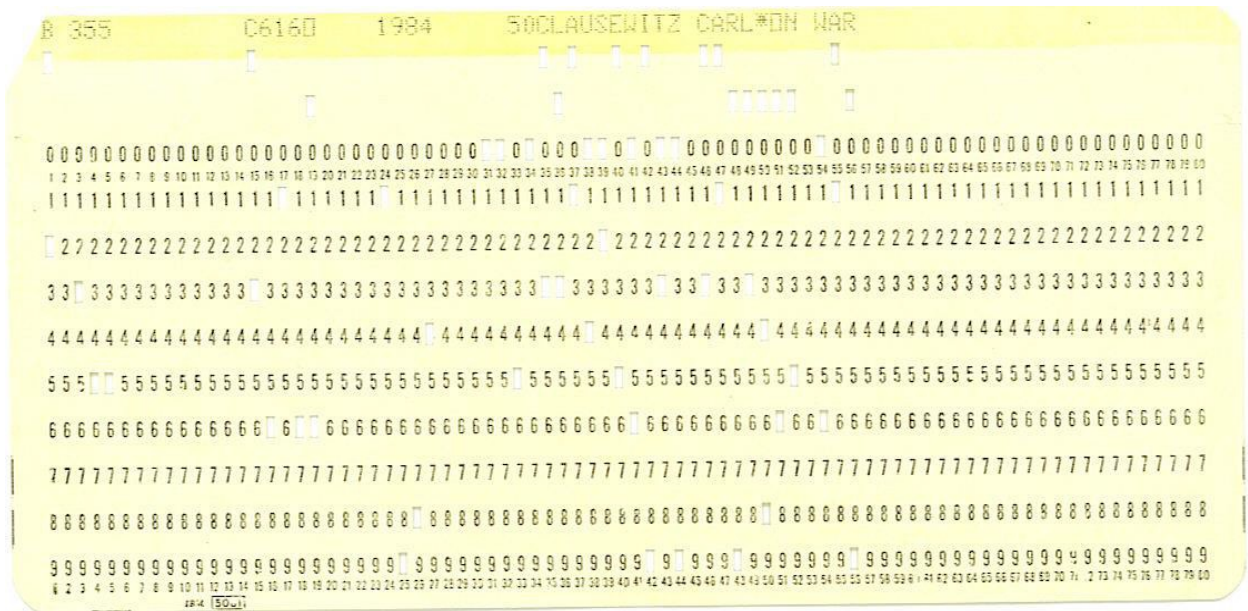


Figure 2.5: 80 Card Column Punch Card

Before the use of Bar Codes and Radio Frequency Identification Technologies to track items in the supply chain and provide “visibility” in the supply chain items were tracked, inventoried, and ordered using the IBM 80 card column punch cards as shown in Figure 2.5. The problem with the punch cards was that they came in a box of several hundred cards to the box. For a warehouse with several thousand items to be inventoried it required printing/punching a card for every stock numbered item prior to the inventory. Usually the punch card “printer/reader” was not in the same location as the warehouse. This resulted in having to transport the boxes of cards to the warehouse.

On one particular day in Hawaii, I watched a box of cards get blown out of the hands of the warehouse worker who was transporting the cards. As strong as that wind was, I am convinced that the cards were scattered all across the islands. The result was a day delay in starting the inventory process.

Bar codes made their appearance in the early 1960s. The US Army started the use of bar codes to track and inventory equipment. The goal of the Army’s systems (LOGMARS – Logistics Marking System) was to put a bar code on every vehicle before it was shipped to Viet Nam. The process proved to be cumbersome and expensive and was dropped before it could prove its value. Perhaps a little testing would have prevented the loss of visibility of products being shipped into Viet Nam.

Bar codes are a series of vertical lines and spaces. The Universal Product Code has a series of digits. Prior to 2005, the United States and Canada used a 12 digit product code but

moved to the Universal Product Code (UPC). The digits in the bar code identify the country of origin, the company that made the product, the product itself and a digit that is assigned to verify that the code was properly read (Figure 2.6). The UPC is a one-dimensional bar code meaning it can only be read in a certain sequence. The use of the bar code enables the company to capture point of sale data that can be used to reduce some of the uncertainty in the supply chain and provide information to suppliers. Figure 2.7 is an example of a two dimensional or 2D bar code that can be read from multiple angles (some references call this form of bar code a QR Code). Figure 2.7 is an example of a two dimensional or 2D bar code that can be read from multiple angles. Bar codes are also used for item identification purposes as shown in Figure 2.8.



Figure 2.6: Example of a Universal Product Code



Figure 2.7: 2D Bar Code (also known as a Quick Response or QR code)



Figure 2.8: Identification Bar Code

Radio Frequency Identification Technology and Supply Chain Information Systems

Radio Frequency Identification Tags will be discussed in greater detail under process design; however, these tags have a large part to play in today's supply chain systems. The use of RFID tags has been the promise of the industry for several years as the best way to track and identify items in the supply chain. The use of RFID provides the benefits of scanning that bar codes provide but also enable quicker inventories and more accurate inventories through the use of the scanners. The problem with RFID tags is three-fold. The first major problem is the cost of the tags and the infrastructure to read and store the tag data. This is no small investment. The second problem is that RFID tags cannot be read through liquids, can only be read from close distances, and may not be compatible with products such as cell phones. The third problem is that until 2018 no one was working on an encrypted RFID tag to protect company information.

Gillette started a program in 2001 to track Mach 3[®] razors in the supply chain. The company was losing visibility of the product and was losing money on these losses. The cost of

the tags was about \$0.75 a piece making the test an expensive one. However, the company discovered that the losses were not a result of internal or even external theft. The test with the razors revealed that the expensive razors were being mishipped to retailers. As is usually the process in supply chain issues the customers that received too many were not complaining and the customers that were shorted were quick (as they should be) to identify a short shipment. This test enabled Gillette to solve their supply chain problem. Figure 2.9 shows an RFID tag on a pallet in Kuwait.



Figure 2.9 RFID Tag on a Pallet

Information Benefits and Drawbacks

A good supply chain information system will enable the company to replace inventory with information. This always sounds like a bold claim. How is it possible to sell the customer a product if all we have is information? The goal is not to get rid of inventory all together but if a company can get better information in their supply chain operations and between their supply chain partners, the need to have excessive piles of inventory to cover the fluctuations in information flow in the supply chain will be reduced. If the need for the piles of stuff is reduced throughout the supply chain, then as the inventory levels decrease across the supply chain it gives the illusion that the inventory has been replaced by information. Actually, it is not an illusion, the better and the more accurate the information the ability to reduce inventory is enhanced and supply chain costs are reduced.

Better supply chain information systems lead to a better flow of information. This leads to better collaboration between supply chain partners. Better information flows, better collaboration, and reduced variability in the supply chain lead to shorter cycle times to make and distribute products. Shorter cycle times lead to greater customer satisfaction and this usually leads to higher profit levels.

However, there are downsides of sophisticated supply chain information systems. The first is that they are more vulnerable to cyber security issues. As we will see in the chapter on Supply Chain Security, security/preparedness is a very large problem in today's supply chains. Cyber security risk is an ever-increasing problem. Another downside of e-commerce and supply chain information systems is that more and more companies are learning that just having a great Web site is only part of the success equation. The other half of this success equation is the ability

to get the product delivered to the customer. There is a direct link between the capability of the supply chain information system and success of the company.

Sourcing—Finding Suppliers, Cultivating Suppliers, Partnering with Suppliers

“Sourcing decisions are important within the supply chain and rely on standards and policies being maintained.”¹⁴

As purchased supplies, parts, components, and materials account for almost half of all manufacturing costs it is important to pick the right suppliers and sources of supply. It is equally important to collaborate with suppliers to share information to reduce the variability in the supply chain and it is also important to cultivate your suppliers.

Just what does cultivating suppliers mean? Part of the cultivation process is to get suppliers to work with your company. It also includes working closely with the suppliers to get win-win terms and better products. By working with the suppliers, it strengthens the supply chain. Because the supply chain is only as strong as its weakest link, by working with suppliers and helping suppliers develop their employees while understanding the needs of your company better, the company ensures that they are not the weakest link. Cultivating suppliers means seeking to understand what drives them and establishing long-term relationships with the suppliers.

¹⁴ APICS Operations Management Body of Knowledge, 2nd edition, APICS, 2009, p. 12.

Partnering with suppliers makes sense when a holistic view is taken of the supply chain. In the days when all of the functions of what is now called a supply chain were under separate silos, partnering was not always sought with suppliers. When the entire supply chain is viewed as interdependent, it becomes obvious that supply chain partners should work together. As we saw in the product development phase, by partnering with suppliers may very well produce better quality products.

Sourcing is important whether it is for purchasing raw materials, component parts or services that the company needs in the process of manufacturing products. Sourcing is also important in the form of outsourcing when a company makes the strategic decision to outsource processes or services that are not deemed to be the core competencies of the company. Outsourcing has become a strategic decision and not just a short term fix for capacity or manufacturing shortfalls.

Single sourcing can trace its roots to Just-in-Time and the 14 points of quality set forth by Dr. Deming. One of the concepts of Just-in-Time is the idea of establishing long-term relationships with suppliers. This is the concept of single sourcing. Single sourcing is often confused with sole sourcing. So, it is important to explain the difference between the two.

Single sourcing occurs when there are multiple sources for the product, raw material, or service. However, even though there are multiple suppliers or sources of supply, the company or purchasing agents choose to go with one supplier. It is like going to the grocery store – there are multiple grocery shopping options in almost every town. However, most consumers shop the same store habitually. It could be because of the selections, the prices, the fuel points, or simply

because it is convenient and on the way home. Whatever the reason, choosing to do business with one source when there are several or many sources is still single sourcing.

Single sourcing has advantages and disadvantages. The obvious advantage is the partnering with one supplier. The fortunes of both companies may be tied to this partnership and single sourcing decision. The biggest disadvantage of single sourcing is putting all of your eggs in one basket. If there are multiple sources but the company chooses to use only one source and that source goes out of business or has financial difficulties as several automobile manufacturers recently discovered, there will be a big problem. If the company does not do any business with the other available suppliers or sources and then is forced to do business with them, the company may find out that the capacity is not there to meet the needs for manufacturing or may end up paying more for the product or service than was originally budgeted for.

Ok, so what is sole sourcing and how does it get confused with single sourcing? Sole sourcing is when only one supplier or source of supply is available for the commodity or product that the company needs. The limit to a sole source may come as a result of a patent or scarcity of the commodity or product.

In US Government procurement and sourcing there is a law that anything over \$10,000 has to go out for competitive bid. However, there is often a misuse of “sole sourcing” to get around this law. The term sole source is often used when in fact there is a desire for single sourcing but as a way to get past Government contracting regulations. Although legal, it is not necessarily ethical. Care is needed in sourcing to ensure that ethics are applied to the supplier sourcing decisions.

Distribution

Here is an example from a recent posting to the Federal Business Operations Web site. One particular US Government office wanted a course in leadership for its executives. In order to bypass the guidelines of the Federal Acquisition Regulation for competition and bidding, this particular agency stipulated that this contract was to be a sole source contract as only one company had taught this particular course in the past. A little research revealed that this particular course had only been taught once before. Was this sole source company the only company capable of teaching a leadership development course for new executives? Of course, not. But since this course had only been taught once before, by stipulating that the company had to have taught the course before made this a de facto sole source contract when it should have been a single source decision.

This is the supply chain function most frequently referred to as logistics. Distribution is the physical movement of products forward in the supply chain. It includes the movement between storage facilities and from storage facilities to the end users. The receipt, storage, picking of the product, and the shipping of the products are part of the distribution functions. In order to be successful in today's supply chain operations, speed is critical in distribution operations.

Under the Distribution umbrella is the operation of warehouses and distribution centers. Warehousing and distribution are often used interchangeably. They are not the same thing and

should not be used as interchangeable terms. We will look at distribution in greater detail in another chapter.

Warehouses focus on the storage aspect of the distribution umbrella. Warehouses are usually smaller than distribution centers. Warehousing is not a new industry. Prehistoric drawings indicate that early man stored food to get through the long winters. In Biblical times, Joseph ran the warehouses for the Pharaoh in Egypt as early as 1718 BC, leading to the Israelites' journey to Egypt and the resultant Exodus led by Moses back to Israel. History is filled with stories of warehousing of various goods and food stuffs.

Warehouses can take the form of product-focused warehouses such as a cold storage and wet storage warehouses for food or a dry storage warehouse for items with longer shelf lives that do not require wet or cold storage. Warehouses can also be long-term storage facilities. These facilities may be collocated with a distribution center or feed the distribution centers but should never be confused with distribution centers. For example, the Federal Emergency Management Agency operates warehouses for storage of disaster contingency operations. Some of these items may remain in storage for over a decade.

Distribution centers, on the other hand, focus on the rapid movement of the goods through the supply chain. Some of the largest industrial buildings are distribution centers. The average new distribution center today is in excess of one million square feet. In 1998, at the Warehousing Education and Research Council Annual Conference in Anaheim, California, a large number of distribution executives were heard to complain that warehousing was going to

become obsolete as a result of the advent of the Internet and online retailers selling direct to the consumer. It was similar to Chicken Little running around crying, “the sky is falling in.”

These executives were partially right. Warehousing and Distribution as it was known in the 1990s went away but resurfaced as a totally reformed industry. The advent of the Internet and the ability of the customer to order individual products online changed the distribution industry in two large ways. The first change in the distribution industry and distribution centers came as a result of the individual customer order quantities.

With customers ordering directly from the companies’ web sites a new organization for the distribution centers was required. Now distribution centers were required to have a single item pick area, a case lot pick area, and pallet storage or bulk storage. A single pick area is where distribution workers can pick individual items to meet customer orders for eaches. This is an addition to the traditional case lot pick areas to support retail store orders and the pallet storage or bulk storage areas in the facility supports the restocking of the case pick and single pick locations in the distribution center. Some companies have moved to fulfillment centers or distribution centers that only serve e-commerce sales rather than try to mix e-commerce support with brick and mortar store support operations.

The second impact to the distribution centers as a result of websites is the addition of a returns area as a result of customers returning items ordered over the Internet that did not meet their needs. The impact of reverse logistics will be discussed in greater detail in the chapter on Reverse Logistics.

The addition of the single picking area and the returns processing areas to the distribution centers not only added more responsibilities to the distribution centers it also added a requirement for more space to the distribution centers. So, the executives may have been wrong about warehousing and distribution going away, but in a way, they were right in saying that distribution centers and distribution operations have changed dramatically with the advent of the Internet.

Another change is the concept of postponement. The change started with the increased competition in the distribution industry because of Third Party Logistics providers—known as 3PLs. A Third Party Provider is a company that only focuses on supply chain and logistics operations as their core competency. Postponement is a value-added service provided by the distribution center. These value-added services may be as simple as placing price tags on the products before shipping from the distribution center.

Distribution Information Systems

Warehouses and Distribution Centers are not the same thing. Warehouses tend to store products for longer periods of time. While warehousing (storing products) takes place in Distribution Centers, the storage period is much shorter. Some of the confusion comes from the fact that the term warehouse has been around for almost four thousand years. And part of the confusion between distribution centers and warehouses comes from the fact that both type facilities are managed by sophisticated automated management systems that are simply referred to as Warehouse Management Systems or WMS. These automated systems started out for the management and automation of warehouses and as warehouses starting morphing into distribution centers, the name of the system did not change.

These systems have become very sophisticated over the past 20 years. A good WMS will not only provide the distribution center with instructions on what should be placed where in the center (this is known as slotting¹⁵) but will also provide the workers with the picking lists. A pick list provides the workers with the instructions of what items on the shelves need to be “picked” and prepared for shipment to the customer. The newer WMS will also provide the workers with the packing instructions and a good WMS will also provide the loading plan for the outbound trucks.

In addition to automating the receiving, storage, picking, packing, and shipping of the goods in the warehouse or distribution center, a WMS may provide management of the outside storage areas and may also provide a system for time and attendance accounting. In one implementation we used the WMS in conjunction with an RFID system to track workers arrival and departure times as well as tracking productive time and break times. This data not only identified nonproductive activity by some of the workers, but it also enabled the distribution center to forecast employee requirements and scheduling needs.

¹⁵ Slotting is the process of placing items in the distribution center or warehouse. Slotting may be either random where any vacant slot can be used for the next inbound item or the slotting may be dedicated slotting. In dedicated slotting, every item has a set location in the facility which leads to worker familiarity of the locations. In random slotting the primary advantage is that spaces do not sit empty waiting for its assigned goods to be replenished. This helps to optimize space utilization but also takes away the advantage of the dedicated slotting of knowing where items are always located.

Transportation

A very important part of the supply chain umbrella is Transportation. The US Army transporters have a saying, “Nothing happens until something moves.” This is true in the commercial supply chain. You can have the best distribution center, you can have the best manufacturing facility and the best product on the market, but if your company cannot deliver the product due to a lack of transportation assets, your supply chain is a failure.

The supply chain is a system of interrelated activities. The key here is that the system is a chain of operations that depend on each other to be successful. Transportation is part of this system of interrelated activities. In the transportation world there are modes of transportation and transportation nodes.

The modes of transportation include railroads, highway transportation, water transportation nodes (to include ocean movements and barge movements), and air transportation. The nodes within the transportation network are the locations where shipments are placed on one of the modes of transportation. Nodes include rail sidings, ocean terminals, rail terminals, airports, distribution centers, and cross-docking facilities.

Transportation may take the form of intermodal operations. Intermodal operations are simply freight moving by more than one mode of transportation. Intermodal could be rail to truck, ocean carrier to truck to rail to truck or even truck to air to truck. International freight most commonly becomes intermodal freight as the ISO (International Standards Organization) twenty- and forty-foot containers move from a ship docking on the West Coast to a train for movement

East and then by truck to the distribution center or retail facility. Figure 2.10 shows intermodal operations on a train transporting containers that were initially transported via ship.

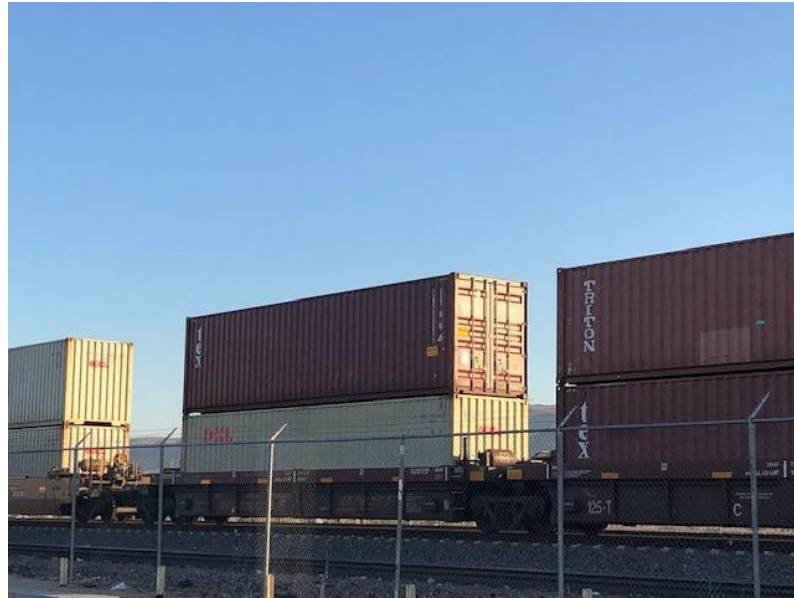


Figure 2.10: Intermodal shipment of containers in Barstow, CA

Rail

There are certain commodities that can only move by rail. Coal is an example, and some chemicals can be more safely transported by rail than by truck. Having worked for the railroads for a short time, I know that the major rail companies are working hard to become more user-friendly. BNSF, for example, established a contract in 2004 to work with the US Military to provide better service while determining the real transportation requirements. The use of double stacking of rail cars is another example of efforts to improve service. Another example of the rail

companies working with their customers to improve service is the covered, bi-level car carrier rail cars. The automobile companies complained to the rail companies about the damages that their cars were incurring during the shipment from the West Coast to other parts of the United States. With the threat of losing this lucrative business, the rail companies designed the covered car carrier to protect the cars while in transit on the trains. Figure 2.11 shows rail operations at Yermo, CA. In this picture, military vehicles are loaded onto the rail cars for shipment back to their home stations after being used in desert training at the US Army National Training Center. These vehicles are moved via truck to the National Training Center and then by truck back to the Yermo Rail Yard.



Figure 2.11: Rail Operations in Yermo, California

One of the disadvantages of rail is that it is slower than other modes of transportation. Although weight-wise the majority of freight in the United States moves by rail, rail movements

are considered inflexible. Rail is considered inflexible because in order to use rail as a mode of transportation requires a rail siding. Whereas a truck can deliver almost anywhere, a shipment by rail requires a rail siding in order to offload the shipment. Figure 2.12 shows a rail siding/spur for loading and off loading equipment and vehicles from the rail cars.



Figure 2.12: Rail Siding for Off-loading Equipment and Vehicles from Rail Cars

On the flip side the advantages of rail include the fact that as mentioned earlier, certain commodities and oversized products can only move via rail. With the advent of the ISO shipping containers in the late 1970s, the use of rail for intermodal shipments increased dramatically. Because of the cost, intermodal shipments can move across the country on rail cheaper than

trucking the goods across country. Another advantage of rail is the concept of trailers on flatcars or moving semi-trailers on the flatcars and then hooking a tractor to the trailer at the off-load site. Figure 2.13 shows commodities that can only move on rail cars (737 air frames) loaded on special rail cars for shipment to the assembly plant in Washington State.



Figure 2.13: Airframes on Rail Cars for Shipment

Ground/Road/Truck Transportation

The majority by volume (not weight) of the freight in the United States moves by truck.¹⁶ The trucking industry is divided between Truckload and Less Than Truckload companies. Truckload companies only move full truckloads of freight. Customers receive a flat rate for the entire truck. This rate for the full truck load is less than the cost of shipping less than truckloads. This is possible because the customer is only having the products delivered to one location.

Less Than Truckload (LTL) firms charge the customers a piece rate based on the weight and cube of the items. LTL firms usually consolidate multiple shipments to form a full load. LTL is advantageous to those companies that do not need to hire a full truckload (TL) for their products. LTL companies can team up with freight consolidators like Freightquote.com to get full shipments. Companies like Freightquote.com¹⁷ use computer software programs to match the excess shipping capacity of shipping companies with shipping requirements of customer companies to provide a win-win-win situation. The shipping companies win because they get full loads and fill up their excess capacities to help optimize profitability. The customers win because they get basically TL equivalent rates for their shipments. And, Freightquote.com gets a commission for matching shippers with customers. Over the past few years Freightquote.com has

¹⁶ Approximately 70-75% of all of the individual items that move in the US move by truck at some point in the supply chain.

¹⁷ For more information on freightquote.com go to www.freightquote.com

moved into matching shipping requirements for international and intermodal shipments in addition to LTL and TL shipping.

The advantage of truck transport over rail transport is the ability to move smaller packages and the ability to deliver to almost any site as long as material handling equipment and a dock or mobile ramp is available. The disadvantage of truck transport is that certain items are not transportable by truck. The advantages of truck are the disadvantages of rail and the advantages of rail are the disadvantages of trucking. Another problem with trucking in the twenty-first century is the aging of the truck drivers. The projection is that there will be a shortage of ten thousand drivers within the next ten years. The growth of e-commerce only adds to the shortage of drivers.

Small Package Carriers and Air Transport

Federal Express (now known as FedEx) was formed by Frederick Smith in 1971 and started providing express shipments in 1973. FedEx established its headquarters in Memphis primarily because the weather in Memphis. As FedEx expanded its operations through expansion and acquisitions, the services and options to deliver “the world on time” became more expanded. To ensure the overnight delivery promise, FedEx controls all operations from their Worldwide Operations Center in Memphis in the facility previously housing the Holiday Inn Reservations Center. This facility has multiple large screen displays of weather, flights, and package shipment information.

FedEx flies an empty plane from the Northwest United States (Seattle/Tacoma, WA) daily down the West Coast and then across the country to Memphis as a precaution and an empty

plane from the Northeast United States (Portland, ME) down the East Coast and across to Memphis as backup in case one of the scheduled FedEx planes is forced to make a precautionary landing or has mechanical problems. These planes help ensure that FedEx can deliver the “world on time.”¹⁸

As operations are expanded to International deliveries, “the world on time” can be defined by the customer—the options include next day morning, next day before 10:00 a.m., before noon, afternoon, second day, and now FedEx ground. One of the value-added services that FedEx now provides is customs clearance for International shipments. In fact, in the Memphis Hub for FedEx there is an entire floor dedicated to customs.

United Parcel Service has been delivering packages for over 100 years. Although started in 1907, it was not until 1982 that UPS started offering second day air service in addition to its package service. Another small package carrier, DHL, was originally formed in 1969 in California. In 1998, DHL was purchased by the Deutsche Bundespost, the German postal and communications company.

The growth of Internet companies coupled with the desire of customers to have their products “now” have led to the growth of the small parcel and air transport companies. These companies offer the ability to ship relatively small packages (usually under 400 pounds) with

¹⁸ During the 2020 COVID-19 Pandemic and corporate shutdown by government decree led FedEx to temporarily suspend their on-time guarantees.

relatively accurate shipping and delivery. In addition, the ability to track the packages not only makes this service popular with customers but also increases customer expectations and satisfaction. Some of the companies offer better online tracking than others.

Small parcel shippers offer this service at a relatively high cost when compared to other modes of transportation. However, this is relative. If the customer wants a product tomorrow or needs the product by tomorrow, then the question becomes, “is it better to pay for premium air transportation or let the customer go somewhere else?”

Water Transport



Figure 2.14: Barge Movement



Figure 2.15: Ocean Movement – A cargo ship being off loaded in the Port of Honolulu

Water transportation is one of the oldest forms of transportation and may take the form of barge movements as shown in Figure 2.14 in Honolulu Harbor and used with great frequency in the United States on the inland rivers and throughout Europe to clear the major ports and move goods inland to the interior countries. There are over 900 barge movements daily out of the Port of Rotterdam into Central Europe.

Water transportation may take the form of ocean shipments as shown in Figure 2.15. This figure shows a ship being off loaded in the Port of Honolulu. Ocean shipments are the most common form of International shipping with over 500 million containers (Twenty Foot Equivalent) moving around the world on ships.

Some products must be moved via water. The sheer volume of materials coming out of Asian Countries prohibits movement via air. The Panama Canal recently completed construction of new, wider locks to accommodate the larger vessels moving this cargo around the globe.

Figure 2.16 shows one of these ships moving in the newer Cocoli Locks.



Figure 2.16: Ship moving through the expanded Panama Canal locks

When it was constructed in 1912-1913, the canal was built to accommodate the widest military ships at the time. This constraint from one hundred years ago limits the size of ships through the canal to about 5,000 containers. The expanded canal now accommodates ships up to 14,000 containers. After the construction started on the new canal locks, Maersk Lines introduced a new cargo ship that can move up to 18,000 Twenty Foot Equivalent containers. The picture in Figure 2.17 shows a ship moving through the older locks of canal.



Figure 2.17: Movement through the Panama Canal Gatun Locks (Pacific to Atlantic Transit)

The advantage of water transportation is that it can move bulky items internationally and intra-nationally. Water transport is inexpensive compared to trying to ship items internationally via air and obviously movement between continents is easier and, in some cases, only possible using water. The disadvantage of water movement is that it is slower than other modes of transportation. This disadvantage became exacerbated in 2009 when the Maersk Lines announced that they could save \$1 billion (USD) by cutting transit speeds in half. This immediately doubled the shipping times and at the same time increased dramatically the amount of goods in transit and not available to the customers. Couple this decrease in shipping speeds with the slowdowns resulting from security concerns and the movement of goods via water becomes a longer supply chain with increased risks.

Pipelines

One other mode of transportation should be discussed to complete the transportation aspect of supply chains—the movement of products via pipelines. Although experiments have been ongoing for years to move slurry coal via pipelines, the most common use of pipelines is for liquid products such as water or petroleum products. The advantage of pipelines over other modes of transportation is that the pipeline can be put in place and move large quantities of liquid products over any type of terrain and in almost any weather condition. The use of pipelines is relatively secure except when folks take pot shots at over ground pipelines as happened in Alaska a few years ago. When this happens, there are problems. Security is not always assured as the US Army discovered during the war in Viet Nam—during this operation, the Army lost as much product to pilferage and theft as it delivered every day.

Pipelines have a relatively high initial cost to dig the foundation and lay the pipeline. However, after the pipeline is in operation, the costs of operations are low. A little pipeline maintenance is needed occasionally as seen in the James Bond movie, *Diamonds Are Forever*, in the early 1970s. An occasional welding job inside the pipeline is needed and some minor preventive maintenance is needed on the pipeline and its pumps but for the most part the pipeline needs very low maintenance. There is a pipeline that runs through Leavenworth County in Kansas (Figure 2.18) and the Central European Pipeline provides product throughout the European Continent.



Figure 2.18: Pipeline running through Leavenworth County, Kansas

Illegal Supply Chains

No discussion of supply chains would be complete without at least a short discussion of some of the illegal supply chains in operation. Figure 2.19 and 2.20 are two of the animals that are illegally hunted for some of their parts. The rhino in Figure 2.19 is hunted and killed for the horn. The rest of the animal is left to rot. In 2019, a group of hunters seeking to poach and kill rhinos accidentally stumbled into a pride of lions – these hunters became a readily available food source for the lions. Apparently in some cultures, the rhino horn is seen as an aphrodisiac – problem is that the horn of the rhino is the same collagen in your fingernails. The elephant shown in Figure 2.20 is hunted for the ivory in their tusks.



Figure 2.19: Rhino in the wild – illegally hunted for their horns



Figure 2.20: Elephants – illegally hunted for the ivory in their tusks

This concept of hunting animals for a part of their body is not new. Some estimates place the Buffalo population in Kansas in the 1860s at approximately 16 million. Buffalo tongue was

considered a delicacy on the east coast of the US and hunters would kill the buffalo, cut off the tongue and leave the rest of the animal to rot. Compare this to my ancestors who would only hunt for food and other needs and would use the entire animal for their needs. Today there are only a few buffalo in Kansas – there are some outside the gate of Fort Leavenworth, a few at Fort Riley and some herds raised for meat. We have to be conscious of what we are doing in the supply chain and think about sustainability.

Summary

In 2005 (updated in 2007), Thomas Friedman wrote *The World Is Flat*. This *New York Times* best seller postulated that the globalization of supply chains has significantly contributed to the “flattening” of the world. The globalization of supply chains has opened the doors to many companies and countries using the Internet. The opening of trading partners and trade agreements has helped to extend supply chains. The European Union is a good example of a trading partnership/trading bloc that has helped to globalize operations by creating stronger bonds and using the trading blocs to help take advantage of the advantages of economies of scale to improve supply chain operations.

The downside of globalized supply chains is tied to security and quality. The sheer numbers of containers moving around the world contributes to supply chain security issues as does the extended supply chains that are more open to terrorist interdiction and disruption of the supply chain. Sourcing from unknown sources around the globe can and in some instances creates quality issues and concerns.

Everything is supply chain related from sourcing to delivery of the finished product. The SCOR Model describes the supply chain as reaching from the suppliers' suppliers to the customers' customers and includes the basic functions of Plan, Source, Make, Deliver, Return and Enable (this textbook is organized around those functions). Everything we do in any part of Operations Management is related in some form or fashion to Supply Chain Operations whether we are in the business of providing goods or services to the customer. To be successful in Operations Management, a company has to be successful in supply chain management.

Discussion Questions

1. What is the difference between warehouses and distribution centers?
2. Many discussions of supply chains use the terms logistics and supply chains interchangeably. Is this accurate or are the two different? If they are different, how do they differ?
3. What are the advantages of the different modes of transportation?
4. Logistics was derived from the Military as a concept. In today's supply chain, what function is closely associated with the military logistics concept of moving supplies and personnel?
5. What is intermodal transportation?
6. How has the distribution center been impacted by the increase in customers ordering direct from the manufacturer via the Internet?
7. What is the mode of transportation most common for International shipping? What impact does this have on the supply chain?
8. What are the functions of the Supply Chain Council's "Supply Chain Operations Reference" Model?

9. Describe the supply chain for an item of clothing in your closet.
10. What does cash-to-cash have to do with supply chain operations?
11. What is the difference between single sourcing and sole sourcing? Define each of the concepts.
12. What part does information have in the operation of supply chains?
13. What is the role of bar codes in today's supply chains? What does an RFID tag provide supply chains that a bar code does not? If no improvement or advantage, why would you use an RFID tag?