Operations Management

Supply Chain

7.1   What is a Supply Chain?

A **supply chain** is the network of activities that delivers a finished product or service to the customer. These include sourcing raw materials and parts, manufacturing and assembling the products, warehousing, order entry and tracking, distribution through the channels, and delivery to the customer. An organization's supply chain is facilitated by an information system that allows relevant information such as sales data, sales forecasts, and promotions to be shared among members of the supply chain.

At the beginning of the chain are the external suppliers who supply and transport raw materials and components to the manufacturers. Manufacturers transform these materials into finished products that are shipped either to the manufacturer's own distribution centers or to wholesalers. Next, the product is shipped to retailers who sell the product to the customer. Goods flow from the beginning of the chain through the manufacturing process to the customer. Relevant information flows back and forth among members of the supply chain.

7.2   Supply Chain Management

Supply chain management is the vital business function that coordinates and manages all the activities of the supply chain linking suppliers, transporters, internal departments, third-party companies, and information systems. Supply chain management for manufacturers entails:

- Coordinating the movement of goods through the supply chain from suppliers to manufacturers to distributors to the final customers

- Sharing relevant information such as sales forecasts, sales data, and promotional campaigns among members of the chain

A prime example of operations management (OM), supply chain management provides the company with a sustainable, competitive advantage, such as quick response time, low cost, state-of-the-art quality design, or operational flexibility. Dell Computer Corporation is a good example of a company using its supply chain

to achieve a sustainable competitive advantage. Quick delivery of customized computers at prices 10–15 percent lower than the industry standard is Dell's competitive advantage. A customized Dell computer can be en route to the customer within 36 hours. This quick response allows Dell to reduce its inventory level to approximately 13 days of supply compared to Compaq's 25 days of supply. Dell achieves this in part through its warehousing plan. Most of the components. Dell uses are warehoused within 15 minutes travel time to an assembly plant. Dell does not order components at its Austin, Texas, facility; instead, suppliers restock warehouses as needed, and Dell is billed for items only after they are shipped. The result is better value for the customer.

7.3 Components Of A Supply Chain For A Manufacturer

A company's supply chain structure has three components: external suppliers, internal functions of the company, and external distributors. External suppliers include the dairy farmer, cardboard container manufacturer, label company, plastic container manufacturer, paper mill, chemical processing plant, lumber company, and chemical extraction plant. Internal functions include the processing of the raw milk into consumer dairy products and packaging and labeling dairy products for distribution to retail grocery outlets. The external distributors transport finished products from the manufacturer to retail grocers, where the products are sold to the customer.

The supply chain includes every activity from collecting the raw milk, producing the consumer dairy products, packaging the dairy products, distributing the packaged dairy products to retail grocers, to selling the finished dairy products to the customer. Let's look at each component of the supply chain in detail.

7.3.1 External Suppliers

Dairy products manufacturing involves several companies. The dairy products are packaged either in cardboard or plastic containers made by **tier one suppliers**. Note that any supplier that provides materials directly to the processing facility is designated as a tier one supplier (in this case, the dairy farm, the cardboard container manufacturer, the label company, and the plastic container manufacturer). The paper mill and the chemical processing plant are **tier two suppliers** because they directly supply tier one suppliers but do not directly supply the packaging operation.

The lumber company that provides wood to the paper mill is a **tier three supplier**, as is the chemical extraction plant that supplies raw materials to the chemical processing plant. Companies put substantial effort into developing the external

supplier portion of the supply chain because the cost of materials might represent 50–60 percent or even more of the cost of goods sold. A company is typically involved in a number of supply chains and often in different roles. Even though the plastics container manufacturer was a tier one supplier to the milk processing facility, the plastic container manufacturer still has its own unique supply chain. Now consider the supply chain for a retail grocer: the tier one suppliers are providers of packaged consumer products, and the grocer has no external distributors because the customers buy directly from the store. As you can see, supply chains come in all shapes and sizes. Remember that tier one suppliers (the cardboard container manufacturer, dairy farm, label company, and plastics container manufacturer.

7.3.2 Internal Functions

Internal functions in, for example, a dairy products supply chain are as follows:

1) Processing, which converts raw milk into dairy products and packages these products for distribution to retail grocery outlets.
2) Purchasing, which selects appropriate suppliers, ensures that suppliers perform up to expectations, administers contracts, and develops and maintains good supplier relationships.
3) Production planning and control, which schedules the processing of raw milk into dairy products.
4) Quality assurance, which oversees the quality of the dairy products.
5) Shipping, which selects external carriers and/or a private fleet to transport the product from the manufacturing facility to its destination.

7.3.3 External Distributors

External distributors transport finished products to the appropriate locations for eventual sale to customers. Logistics managers are responsible for managing the movement of products between locations. **Logistics** includes *traffic management* and *distribution management*. **Traffic management** is the selection and monitoring of external carriers (trucking companies, airlines, railroads, shipping companies, and couriers) or internal fleets of carriers. **Distribution management** is the packaging, storing, and handling of products at receiving docks, warehouses, and retail outlets. Next, we will look at a common challenge to supply chain managers called the bullwhip effect.

7.4   The Bull Whip Effect

Sharing product demand information between members of a supply chain is critical. However, inaccurate or distorted information can travel through the chain

like a bullwhip uncoiling. The **bullwhip effect**, as this is called, causes erratic replenishment orders placed on different levels in the supply chain that have no apparent link to final product demand. The results are excessive inventory investment, poor customer service levels, ineffective transportation use, misused manufacturing capacity, and lost revenues. We will discuss the causes of the bullwhip effect, and how they send inaccurate or distorted information down the supply chain. First, however, let's look at the traditional supply chain and follow the product demand information flow from the final seller back to the manufacturer of the product:

1) The final seller periodically places replenishment orders with the next level of the supply chain, which could be a local distributor. The timing and order quantity—for example, monthly orders in varying amounts—are determined by the final seller. The timing and quantity can be fixed or variable.
2) The local distributor has many customers (final sellers) placing replenishment orders. Each final seller uses it own product demand estimates and quantity rules. Based on these replenishment orders, the local distributor places replenishment orders with its supplier, which could be a regional distribution center (RDC).
3) As before, the customers (the local distributors) determine the timing and quantity of orders placed with the RDC. Each RDC periodically places orders based on demand at the RDC by ordering from the manufacturer of the finished good.
4) In turn, the manufacturer develops plans and schedules production orders based on orders from the RDCs. The manufacturer does not know what the demand is for the finished good by the final customer but knows only what the RDCs order.

The greater the number of levels in the supply chain, the further away the manufacturer is from final customer demand. Since suppliers in the chain do not know what customer demand is or when a replenishment order might arrive, suppliers stockpile inventory.

7.5   Causes of the Bullwhip Effect
The causes of the bullwhip effect are demand forecast updating, order batching, price fluctuation, and rationing and gaming. Let's look at each of these causes. Each member in the supply chain, beginning with the retailers, does ***demand forecast updating*** with every inventory review. Based on actual demand, the retailers update their demand forecast. The retailers review their current inventory level and, based on their inventory policies, determine whether a replenishment

order is needed. The wholesalers repeat the process. Note that the demand is from the retailers' inventory replenishments and may not reflect actual customer demand at the retail level. The wholesalers update their demand forecast and place appropriate replenishment orders with the distribution centers. The distributors repeat the process, updating their demand forecasts based on demand from the wholesalers. The distributors review their inventory levels and place the appropriate orders with the manufacturer. These orders are determined by the inventory policies at the distributors. Orders placed with the manufacturer end up replenishing each level in the supply chain rather than being directly linked to end-customer demand.

A company does *order batching* when, instead of placing replenishment orders right after each unit is sold, it waits some period of time, sums up the number of units sold, and then places the order. This changes constant product demand to lumpy demand— a situation where certain levels in the supply chain experience periods of no demand. Order batching policies amplify variability in order timing and size.

Price fluctuations cause companies to buy products before they need them. Price fluctuations follow special promotions like price discounts, quantity discounts, coupons, and rebates. Each of these price fluctuations affects the replenishment orders placed in the supply system. When prices are lower, members of the supply chain tend to buy in larger quantities. When prices increase, order quantities decrease. Price fluctuations create more demand variability within the supply chain.

Rationing and shortage gaming result when demand exceeds supply and products are rationed to members of the supply chain. Knowing that the manufacturer will ration items, customers within the supply chain often exaggerate their needs. For example, if you know the company is supplying only 50 percent of the order quantity, you double the order size. If you really need 100 pieces, you order 200 so you are sure to get what you need. Such game-playing distorts true demand information in the system.

7.5.1 Counteracting the Bullwhip Effect
Here are four ways of counteracting the bullwhip effect:
1) Change the way suppliers forecast product demand by making this information from the final-seller level available to all levels of the supply chain. This allows all levels to use the same product demand information

when making replenishment decisions. Companies can do this by collecting point-of-sale (POS) information, a function available on most cash registers.

2) Eliminate order batching. Companies typically use large order batches because of the relatively high cost of placing an order. Supply chain partners can reduce ordering costs by using electronic data interchange (EDI) to transmit information. Lower ordering costs eliminate the need for batch orders.

3) Stabilize prices. Manufacturers can eliminate incentives for retail forward buying by creating a uniform wholesale pricing policy. In the grocery industry, for example, major manufacturers use an everyday low-price policy or a value-pricing strategy to discourage forward buying.

4) Eliminate gaming. Instead of filling an order based on a set percentage, manufacturers can allocate products in proportion to past sales records. Customers then have no incentive to order a larger quantity to get the quantity they need.

7.6   Supply Chains for Service Organizations

Up till now, the discussion has focused on supply chains for manufacturing organizations rather than supply organizations. However, service organizations can also benefit from supply chain management. A supply chain for a service organization is similar to that for manufacturing organizations since external suppliers, internal operations, and external distributors can be needed. In the case of an e-tailer, supply chain management can be used to integrate external suppliers (usually providing better demand forecast information to its suppliers, thus reducing uncertainty within the chain); it has internal operations with regard to order processing, order picking, and so on; and it can have external distribution done by a third-party provider (such as FedEx, UPS, or DHL).

The service can be as simple as making airline, train, hotel, cruise, car rental, or personal tour arrangements for the customer. A customer can require a single type of service or have a highly complicated travel request.

7.6.1 Internal Operations

The internal operations at the travel agency are split into two parts: Travel Enablement and Travel Billing. Travel Enablement begins with qualifying potential suppliers of travel services. The agency does not provide the actual travel but makes the arrangements. The agency must know the scope of services provided, as well as the quality of the services, the reliability of the provider, the safety of the service, the financial solvency, the language capability of the provider, and the like. As people travel throughout the world, it is critical to qualify

any service providers used by the agency. The better the agency develops its external suppliers, the better it can match its customers with the right service providers.

The next step deals with the different forms of credit since no business transaction is completed without assuring the financing first. Providers in many developing nations don't accept credit cards for payment, so it may be necessary to arrange bank transfers (possibly in the local currency) to finalize the service commitment.

The agency must also clarify refund and cancellation policies. Pricing deals with negotiation of terms for delivery of the service and price discounts. Group discounts may be available. Discounts may be offered for services booked during traditionally low seasons. The agency can use integrated cost data, including available discounts and other incentives, to influence customer decisions.

The last process of Travel Enablement is assuring that any risk is minimized for the customer. This can be done by having integrated supplier performance files. The agency can evaluate past performance by the supplier and determine how to minimize any risk associated with using the supplier (a backup provider, just in case) or travel insurance. Travel Enablement is about having a database of service providers that can be accessed instantly for use in arranging real-time travel for customers. Often the customer is sitting at the desk of a travel agent or is on the phone or Internet with the agent. The integrated database facilitates travel arrangements.

Travel Billing includes invoicing, dispute resolution, and payment to suppliers. The agency creates an integrated invoice for its customers. The agency can have both commercial and private accounts. Commercial clients can often receive a consolidated invoice monthly. Most private accounts are invoiced after the trip has been booked. It can include a payment required at time of booking, with the balance due prior to the actual travel. Providing a consolidated invoice reduces the number of transactions with the customer. Often systems for electronic payment are used. The agency can be the focal point for all complaint resolution. This reduces the risk of miscommunications and provides a resolution process for both the customer and the service provider. Payment of the invoice to the agency results in subsequent payment to the service providers. Ideally, payments are processed by data transfer, thus reducing the time to cash for the service providers.

7.6.2 The External Distributors

For the travel agency, the external distributors deliver the actual service to the customer. The external distributor is the service provider of the transportation or tour (the airline, the cruise company, the tour guides, the car rental agency, etc.). Although the agency makes all of the arrangements, the service provider is not part of the agency. Services deal with many of the same issues that face manufacturers. The intent is to integrate the internal operations (arranging for the travel, billing the customer, paying the service suppliers, and tracking the services provided to the customer).

7.7   Major Issues Affecting Supply Chain Management

Information technology enablers for supply chain management include the Internet, the Web, EDI (electronic data interchange), intranets and extranets, bar code scanners, and point-of-sale demand information. We begin by looking at the use of the Internet and the Web as a way of doing business.

E-commerce and e-business are defined as the use of the Internet and the Web to transact business. E-business refers to transactions and processes within an organization, such as a company's on-line inventory control system, that support supply chain management. E-commerce includes B2B (business-to-business) and B2C (business-to-consumer) transactions. Let's take a closer look B2B e-commerce.

In **business-to-business e-commerce**, companies sell and buy products to and from other businesses. B2B represents the largest segment of e-commerce sales transactions. Prior to the Internet, B2B was relatively inefficient. It took time and resources for companies to search for products, to arrange for purchase and payment, to handle shipment, and finally to receive the items. Using the Internet allowed companies to automate at least parts of the procurement process. Significant dollars are saved by organizations due to effective electronic purchasing research and reduced transaction costs. Let's look at how B2B commerce has developed.

7.7.1 The Evolution of B2B Commerce

B2B commerce began in the 1970s with **automated order entry systems** that used telephone models to send digital orders to suppliers. One company, Baxter Healthcare Corporation, placed telephone modems in a customer's purchasing department to automate reordering supplies from Baxter's computerized inventory database. This technology changed in the 1980s to personal computers and in the

1990s to Internet workstations that access on-line catalogs. Automated order entry systems are seller-side solutions. They are owned by the supplier and only offer the supplier's product line. The primary benefits to the customers are reduced inventory replenishment costs and supplier-paid system costs.

In the late 1970s, **electronic data interchange (EDI)** emerged. EDI is a form of computer-to-computer communication standardized for sharing business documents such as invoices, purchase orders, shipping bills, and product stocking numbers. Most large firms have EDI systems, and most inventory groups have industry standards for defining the documents to be communicated. EDI systems are buyer-side solutions: they are designed to reduce the procurement costs for the buyer. EDI systems generally serve a specific industry.

In the mid-1990s, **electronic storefronts** emerged. Electronic showplaces are on-line catalogs of products made available to the general public by a single supplier. These storefronts evolved from the automated order entry systems. They are far less expensive than their predecessors because

1) they use the Internet as the communication medium, and
2) the storefronts tend to carry products that serve a number of different industries.

7.7.2 Net Marketplaces

Net marketplaces emerged in the late 1990s. A net marketplace is designed to bring hundreds or thousands of suppliers (each with electronic catalogs) together with a significant number of purchasing firms in a single Internet-based environment to conduct trade. Covisint (www.covisint.com) is an example of a successful net marketplace. Covisint was started in 1999 by a consortium of the following auto manufacturers: General Motors, Ford Motor Company, DaimlerChrysler, Nissan, and Renault. Its purpose was to address escalating costs and gross inefficiencies within their industry. Covisint leveraged the power and potential of the Internet to solve industry-specific business problems in real time.

Its goal was to deliver a secure marketplace, portal, and application-sharing platform for the global automotive industry. Currently, Covisint has more than 300,000 users that represent more than 45,000 organizations, and does business in 96 countries. Covisint streamlines and automates business processes, globally connecting business communities in the manufacturing, healthcare, aerospace, public sector, and financial services industries.

A net marketplace can also facilitate on-line auctions. Two types of auctions are forward auctions (where suppliers auction excess inventory and receive the market price for their surplus goods) and reverse auctions (where buyers post **electronic requests for quotes (eRFQs)** for goods and services and suppliers bid for business on-line).

A **virtual private network (VPN)** is a computer network in which some of the links between nodes are carried by open connections or virtual circuits on the Internet instead of by physical wires. An organization can have a VPN for use by its own employees as well as suppliers and customers. Through this network, buyers and suppliers can work together on product design and development, manage inventory replenishments, coordinate production schedules, and work as partners.

Access to the VPN is typically password controlled. More than likely, your university has a VPN for your use.

The Benefits of B2B E-Commerce
The potential benefits from Internet-based B2B commerce include:
● Lower procurement administrative costs.
● Low-cost access to global suppliers.
● Lower inventory investment due to price transparency and quicker response times.
● Better product quality because of increased cooperation between buyers and sellers, especially during product design and development.

Business-to-Consumer (B2C) E-Commerce
In **business-to-consumer e-commerce**, on-line businesses try to reach individual consumers. Let's examine the different models that on-line businesses use to generate revenue. In the **advertising revenue model**, a Web site offers its users information on services and products, and provides an opportunity for providers to advertise. The company receives fees for the advertising. Yahoo.com derives its primary revenue from selling advertising such as banner ads.

In the **subscription revenue model**, a Web site that offers content and services charges a subscription fee for access to the site. One example is Consumer Reports Online (www.consumerreports.org), which provides access to its content only to subscribers at a rate of $3.95 per month. Companies using this model must offer

content perceived to be of high value that is not readily available elsewhere on the Internet for free. In the **transaction fee model**, a company receives a fee for executing a transaction. For example, Orbitz (www.orbitz.com) charges a small fee to the consumer when an airline reservation is made. Another example, E*Trade Financial Corporation, an on-line stockbroker (www.etrade.com), receives a transaction fee each time it executes a stock transaction.

In the **sales revenue model**, companies sell goods, information, or services directly to customers. Amazon.com, primarily a book and music seller, Travelocity.com, an airline and hotel reservations provider, and DoubleClick Inc. (www.doubleclick.net), a company that gathers information about on-line users and sells it to other companies, all use the sales revenue model.

In the **affiliate revenue model**, companies receive a referral fee for directing business to an "affiliate" or receive some percentage of the revenue resulting from a referred sale. For example, MyPoints.com receives money for connecting companies with potential customers by offering special deals. When members take advantage of the deal, they earn points that can later be redeemed for goods.

In addition to the Internet, companies use other technology to help manage supply chains. For example, **intranets** are networks internal to an organization. Intranets allow a company to network groups of internal computers together to form more effective information systems. Typically, members of the organization communicate internally on the intranet. Organizations can link intranet systems of the Internet to form **extranets**. The extranet can be expanded to include both a company's suppliers and customers. Typically, real-time inventory status is available on the extranet as well as production schedules. Extranets allow suppliers and customers to *"see"* within the organization. The primary difference between the Internet, intranets, and extranets is who has access to the system. The Internet is wide open, the intranet is open to members of an organization, and the extranet is open to members of the organization as well as to suppliers and customers.