UNIT – 4

SOURCING AND COORDINATION IN SUPPLY CHAIN

4.1 THE ROLE OF SOURCING IN A SUPPLY CHAIN

Purchasing, also called procurement is the process by which companies acquire raw materials, components, products, services, or other resources from suppliers to execute their operations. Sourcing is the entire set of business processes required to purchase goods and services. For any supply chain function, the most significant decision is whether to outsource the function or perform it in-house. Outsourcing results in the supply chain function being performed by a third party. Outsourcing is one of the most important issues facing a firm, and actions across industries tend to be varied.

It is important to clarify the distinction between outsourcing and offshoring before we proceed. A firm off-shore a supply chain function if it maintains ownership but moves the production facility offshore. In contrast, a firm outsources if the firm hires an outside firm to perform an operation rather than executing the operation within the firm. We address the outsourcing of supply chain activities based on the following two questions:

1. Will the third party increase the supply chain surplus relative to performing the activity in house?

2. To what extent do risks grow upon outsourcing?

Recall that the supply chain surplus is the difference between the value of a product for the customer and the total cost of all supply chain activities involved in bringing the product to the customer. The supply chain surplus is the total size of the pie that all supply chain participants (including the customer) get to share. Our basic premise is that outsourcing makes sense if it increases the supply chain surplus without significantly affecting risks.

Once a decision to outsource has been made, sourcing processes include the selection of suppliers, design of supplier contracts, product design collaboration, procurement of material or services, and evaluation of supplier performance, as shown in Figure 4-1.

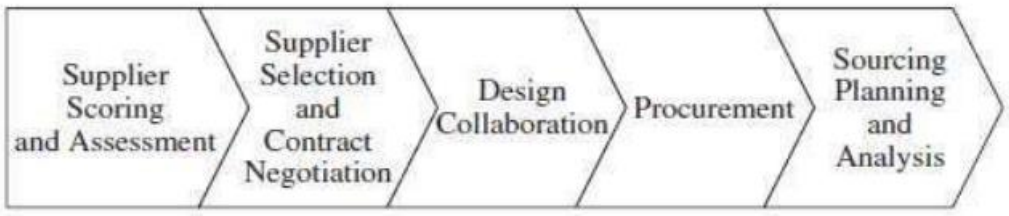

Figure 4.1 Key Sourcing-Related Processes

Supplier scoring and assessment is the process used to rate supplier performance. Suppliers should be compared based on their impact on the supply chain surplus and total cost. Unfortunately, sourcing decisions are often driven based solely on the price charged by a supplier. Many other supplier characteristics, such as lead time, reliability, quality, and design capability, also affect the total cost of doing business with a supplier.

A good supplier scoring and assessment process must identify and track performance along all dimensions that affect the total cost of using a supplier. Supplier selection uses the output from supplier scoring and assessment to identify the appropriate supplier(s). A supply

contract is then negotiated with the supplier. A good contract should account for all factors that affect supply chain performance and should be designed to increase supply chain profits in a way that benefits both the supplier and the buyer.

Given that about 80 percent of the cost of a product is determined during design, it is crucial that suppliers be actively involved at this stage. Design collaboration allows the supplier and the manufacturer to work together when designing components for the final product. Design collaboration also ensures that any design changes are communicated effectively to all parties involved with designing and manufacturing the product. Once the product has been designed, procurement is the process whereby the supplier sends product in response to orders placed by the buyer. The goal of procurement is to enable orders to be placed and delivered on schedule at the lowest possible overall cost.

Effective sourcing processes within a firm can improve profits for the firm and total supply chain surplus in a variety of ways. It is important that the drivers of improved profits be clearly identified when making sourcing decisions. Some of the benefits from effective sourcing decisions are the following:

- Better economies of scale can be achieved if orders within a firm are aggregated.

- More efficient procurement transactions can significantly reduce the overall cost of purchasing. This is most important for items for which a large number of low value transactions occur.

- Design collaboration can result in products that are easier to manufacture and distribute, resulting in lower overall costs. This factor is most important for supplier products that contribute a significant amount to product cost and value.

- Good procurement processes can facilitate coordination with the supplier and improve forecasting and planning. Better coordination lowers inventories and improves the matching of supply and demand.

- Appropriate supplier contracts can allow for the sharing of risk, resulting in higher profits for both the supplier and the buyer.

- Firms can achieve a lower purchase price by increasing competition through the use of auctions.

When designing a sourcing strategy, it is important for a firm to be clear on the factors that have the greatest influence on performance and target improvement on those areas. For example, if most of the spending for a firm is on materials with only a few high value transactions, improving the efficiency of procurement transactions will provide little value, whereas improving design collaboration and coordination with the supplier will provide significant value. In contrast, when sourcing items with many low-value transactions, increasing the efficiency of procurement transactions will be very valuable.

IN-HOUSE OR OUTSOURCE

The decision to outsource is based on the growth in supply chain surplus provided by the third party and the increase in risk incurred by using a third party. A firm should consider outsourcing if the growth in surplus is large with a small increase in risk. Performing the function in-house is preferable if the growth in surplus is small or the increase in risk is large.

How Do Third Parties Increase The Supply Chain Surplus

Third parties increase the supply chain surplus if they either increase value for the customer or decrease the supply chain cost relative to a firm performing the task in-house.

1. Capacity aggregation.

A third party can increase the supply chain surplus by aggregating demand across multiple firms and gaining production economies of scale that no single firm can on its own.

2. Inventory aggregation.

A third party can increase the supply chain surplus by aggregating inventories across a large number of customers. Aggregation allows them to significantly lower overall uncertainty and improve economies of scale in purchasing and transportation.

3. Transportation aggregation by transportation intermediaries.

A third party may increase the surplus by aggregating the transportation function to a higher level than any shipper can on its own. UPS, FedEx, and a host of LTL carriers are examples of transportation intermediaries that increase the supply chain surplus by aggregating transportation across a variety of shippers.

4. Transportation aggregation by storage intermediaries.

A third party that stores inventory can also increase the supply chain surplus by aggregating inbound and outbound transportation. On the inbound side they are able to aggregate shipments from several manufacturers onto a single truck. This results in a lower transportation cost than could be achieved by each manufacturer independently. On the outbound side they aggregate packages for customers at a common destination, resulting in a significantly lower transportation cost than can be achieved by each customer separately.

5. Warehousing aggregation.

A third party may increase the supply chain surplus by aggregating warehousing needs over several customers. The growth in surplus is achieved in terms of lower real estate costs as well as lower processing costs within the warehouse. Savings through warehousing aggregation arise if a supplier's warehousing needs are small or if its needs fluctuate over time.

6. Procurement aggregation.

A third party increases the supply chain surplus if it aggregates procurement for many small players and facilitates economies of scale in production and inbound transportation. Procurement aggregation is most effective across many small buyers. A good example is FleetXchange, a firm that offers small truck fleets lower prices for truck equipment and services through aggregate buying. Procurement aggregation is not likely to be a big factor in a situation with a few large customers.

7. Information aggregation.

A third party may increase the surplus by aggregating information to a higher level than can be achieved by a firm performing the function in-house. All retailers aggregate information on products from many manufacturers in a single location. This information aggregation reduces search costs for customers.

8. Receivables aggregation.

A third party may increase the supply chain surplus if it can aggregate the receivables risk to a higher level than the firm or it has a lower collection cost than the firm. Bright Star is a distributor for Motorola in most Latin American countries other than Brazil. Cell phones in the area are sold through many small, independently owned retail outlets. Collecting receivables from each retail outlet is a very expensive proposition for a manufacturer.

9. Relationship aggregation.
An intermediary can increase the supply chain surplus by decreasing the number of relationships required between multiple buyers and sellers. Without an intermediary, connecting a thousand sellers to a million buyers requires a billion relationships. The presence of an intermediary lowers the number of relationships required to just over a million.

10. Lower costs and higher quality.
A third party can increase the supply chain surplus if it provides lower cost or higher quality relative to the firm. If these benefits come from specialization and learning, they are likely to be sustainable over the longer term. A specialized third party that is further along the learning curve for some supply chain activity is likely to maintain its advantage over the long term. Three important factors that affect the increase in surplus that a third party provides: scale, uncertainty, and the specificity of assets.

RISKS OF USING A THIRD PARTY

Firms must evaluate the following risks when they move any function to a third party.

1. The process is broken

2. Underestimation of the cost of coordination.

3. Reduced customer/supplier contact.

4. Loss of internal capability and growth in third-party power.

5. Leakage of sensitive data and information.

6. Ineffective contracts.

SUPPLIER SCORING AND ASSESSMENT

When comparing suppliers, many firms make the fundamental mistake of focusing only on the quoted price, ignoring the fact that suppliers may differ on other important dimensions that affect the total cost of using a supplier. For instance, suppliers have different replenishment lead times. Does it pay to select a more expensive supplier with a shorter lead time? Or consider suppliers that have different on-time performance. Is the more reliable supplier worth the few extra pennies it charges per piece? In each of the aforementioned instances, the price charged by the supplier is only one of many factors that affect the supply chain surplus. When scoring and assessing suppliers, the following factors other than quoted price must be considered:

- Replenishment lead time
- On-time performance
- Supply flexibility
- Supply quality

- Inbound transportation cost
- Pricing terms
- Information coordination capability
- Design collaboration capability
- Exchange rates, taxes, and duties
- Supplier viability

Supplier performance must be rated on each of these factors because they all affect the total supply chain cost. Next we discuss how each factor affects total supply chain cost and how a supplier's rating on the factor can be used to infer a total cost of using the supplier.

1. Replenishment lead time.
As the replenishment lead time from a supplier grows, the amount of safety inventory that needs to be held by the buyer also grows proportional to the square root of the replenishment lead time. Scoring the performance of suppliers in terms of replenishment lead time thus allows the firm to evaluate the impact each supplier has on the cost of holding safety inventory.

2. On-time performance.
On-time performance affects the variability of the lead time. A reliable supplier has low variability of lead time, whereas an unreliable supplier has high variability. As the variability of lead time grows, the required safety inventory at the firm grows very rapidly.

3. Supply flexibility.
Supply flexibility is the amount of variation in order quantity that a supplier can tolerate without letting other performance factors deteriorate. The less flexible a supplier is, the more lead-time variability it will display as order quantities change. Supply flexibility thus affects the level of safety inventory that the firm will have to carry.

4. Delivery frequency/minimum lot size.
The delivery frequency and the minimum lot size offered by a supplier affect the size of each replenishment lot ordered by a firm. As the replenishment lot size grows, the cycle inventory at the firm grows, thus increasing the cost of holding.

5. Supply quality.
A worsening of supply quality increases the variability of the supply of components available to a firm. Quality affects the lead time taken by the supplier to complete the replenishment order and also the variability of this lead time because follow-up orders often need to be fulfilled to replace defective products. As a result, the firm has to carry more safety inventory from a low quality supplier compared to a high-quality supplier.

6. Inbound transportation cost.
The total cost of using a supplier includes the inbound transportation cost of bringing material in from the supplier. Sourcing a product overseas may have lower product cost but generally incurs a higher inbound transportation cost, which must be accounted for when comparing suppliers. The distance, mode of transportation, and delivery frequency affect the inbound transportation cost associated with each supplier.

7. Pricing terms.
Pricing terms include the allowable time delay before payment has to be made and any quantity discounts offered by the supplier. Allowable time delays in payment to suppliers save the buyer working capital. The cost of working capital savings for each supplier can be quantified. Price terms also include discounts for purchases above certain quantities. Quantity discounts lower the unit cost but tend to increase the required batch size and as a result the cycle inventory.

8. Information coordination capability.
The information coordination capability of a supplier is harder to quantify, but it affects the ability of a firm to match supply and demand. Good coordination results in better replenishment planning, thus decreasing both the inventory carried as well as the sales lost because of lack of availability. Good information coordination also decreases the bullwhip effect and results in lower production, inventory, and transportation costs while improving responsiveness to the customer.

9. Design collaboration capability.
Given that a large part of product cost is fixed at design, collaboration capability of a supplier is significant. Good design collaboration for manufacturability and supply chain can also decrease required inventories and transportation cost. As manufacturers are increasingly outsourcing both the design and manufacture of components, their ability to coordinate design across many suppliers is critical to the ultimate success of the product and the speed of introduction. As a result, design collaboration capability of suppliers is becoming increasingly important.

10. Exchange rates, taxes, and duties.
Although exchange rates, taxes, and duties are not supplier dependent, they can be significant for a firm with a global manufacturing and supply base. In many instances, currency fluctuations affect component price more than all other factors put together. Financial hedges can be put into place to counter exchange-rate fluctuations.

11. Supplier viability.
Given the impact that suppliers have on a company's performance, an important factor in picking a supplier is the likelihood that it will be around to fulfil the promises it makes. This consideration can be especially important if the supplier is providing mission -critical products and it would be difficult to find a replacement for. Note that this is not necessarily a bias for larger companies-many small companies, and even some start-ups, can provide an acceptable level of viability. The factors in Table 4-3 allow a firm to rate and compare various suppliers with different performance on each dimension. We have discussed how performance along most of the factors can be quantified in terms of impact on cost. The overall performance of each supplier can thus be characterized in terms of total cost and a rating on the no quantifiable factors.

4.2 SUPPLIER SELECTION-AUCTIONS AND NEGOTIATIONS

Before selecting suppliers, a firm must decide whether to use single sourcing or multiple suppliers. Single sourcing guarantees the supplier sufficient business when the supplier has to make a significant buyer-specific investment. The buyer-specific investment may take the form of plant and equipment designed to produce a part that is specific to the buyer or may take the form of expertise that needs to be developed. Single sourcing is also used in the automotive industry for parts such as seats that must arrive in the sequence of production. Coordinating such sequencing is impossible with multiple sources. As a result, auto companies have a single seat source for each plant but multiple seat sources across their manufacturing network. Having multiple sources ensures a degree of competition and also the possibility of a backup should a source fail to deliver. A good test of whether a firm has the right number of suppliers is to analyse what impact deleting or adding a supplier will have. Unless each supplier has a somewhat different role, it is very likely that the supply base is too large. In contrast, unless adding a supplier with a unique and valuable capability clearly adds to total cost, the supply base may be too small. The selection of suppliers is done using a variety of mechanisms; including offline competitive bids, reverse auctions, or direct negotiations. No matter what mechanism is used, supplier selection should be based on the total cost of using a supplier and not just the purchase price. Next we discuss some auction mechanisms that are often used in practice and highlight some of their properties.

AUCTIONS IN THE SUPPLY CHAIN

When outsourcing to a third party, firms have historically obtained competitive bids and in recent years have used reverse auctions on the Internet. Competitive bids are a form of auction in which the bids are not revealed to the other bidders. In many supply chain settings, a buyer looks to outsource a supply chain function such as production or transportation. Potential suppliers are first qualified and then allowed to bid on how much they would charge to perform the function. The qualification process is important because there are multiple attributes of that the buyer cares about. When conducting an auction based primarily on unit price, it is thus important for the buyer to specify performance expectations along all dimensions other than price. In reality a buyer may be better off with a multi attribute auction, but in most cases buyers end up with specifications on various attributes and a priceonly auction. The qualification process is used to identify suppliers that meet

performance expectations along the nonprice attributes. From the buyer's perspective, the purpose of the auction is to get bidders to reveal their underlying cost structure so that the buyer can select the supplier with the lowest costs. Commonly used mechanisms for these auctions are as follows.

•Sealed-bid first-price auctions require each potential supplier to submit a sealed bid for the contract by a specified time. These bids are then opened and the contract is assigned to the lowest bidder.

•In English auctions, the auctioneer starts with a price and suppliers can make bids as long as each successive bid is lower than the previous bid. The supplier with the last (lowest) bid receives the contract. The difference in this case is that all suppliers get to see the current lowest bid as the auction unfolds.

• In Dutch auctions, the auctioneer starts with a low price and then raises it slowly until one of the suppliers agrees to the contract at that price.

•In second-price (Vickrey) auctions, each potential supplier submits a bid. The contract is assigned to the lowest bidder but at the price quoted by the second-lowest bidder.

When identifying the auction to use, the firm wants to minimize the price it pays. The firm may also care about ending up with the supplier with the lowest underlying costs because it makes it more likely that the supplier will actually be able to supply at the price it has committed to. A related issue is whether suppliers have any incentive to make false bids that are_not consistent with their cost structure. Such bids may increase what the firm pays and also lead to the contract being given to a firm that does not have the lowest costs.

An important issue with the sealed-bid first-price auction is what is known as the winner's curse. Once selected based on sealed bids, the winner quickly realizes that it could have raised its bid slightly and still won, because other suppliers bid at a higher level. In this sense, winning the bid leads the winner to realize that it left money on the table. Thus, bidders adjust their initial sealed bids upward, taking this phenomenon into account. This issue does not arise in any open auction, where bidders see the current best bid when planning their next bid. This issue also does not arise in the second price auction because the winner gets the price quoted by the second-lowest bidder and thus has no incentive to hide its true cost.

Let us start with the cost structures for suppliers. In most instances it is reasonable to assume that part of the supplier's cost arises from how it has structured its processes and part of its cost arises from market factors such as raw material and labor cost that are common across suppliers.

The following factors influence the performance of an auction:

- •Is the supplier's cost structure private (not affected by factors that are common to other bidders)?
- •Are suppliers symmetric or not, that is, ex ante, are they expected to have similar cost structures?
- • Do suppliers have all the information they need to estimate their cost structure?
- • Does the buyer specify a maximum price it is willing to pay for the supply chain?

Thus, it is in the buyer's interest not only to reveal all public information before bidding but also to convince potential suppliers that all information has been revealed.

A very significant factor that must be accounted for when designing an auction is the possibility of collusion among bidders. Second-price auctions are particularly vulnerable to collusion among bidders. Consider an agreement among bidders under which the bidder with the lowest cost agrees to bid its true cost, with all other bidders bidding a high number (say, the cost of the most expensive bidder or the reserve price of the buyer). In a second-price auction, the lowest cost bidder gets to perform the supply chain function but the buyer has to a pay a higher price than the cost of the second-lowest-cost supplier. This collusion strategy is equilibrium because none of the other bidders has anything to gain by deviating from the collusion agreement. Observe that this collusion strategy can be· avoided with any first-price auction, either sealed bid or English. In either case, a collusion agreement with a very high price will not hold, because many bidders will have the temptation to join the bidding if they have a lower cost. Ultimately, any first-price auction will bring more than the lowest-cost bidder in to the auction.

Collusion results in suppliers suppressing their desire to provide the supply chain function and raising their bids from what would be appropriate given their cost. The price is lowered slowly until suppliers have committed to all units of goods or services desired by the buyer. In this auction, each unit is supplied at a different price. In a multiunit English auction, the buyer starts at a high price and bidders announce the quantity they are willing to supply. If the total quantity that suppliers are willing to supply exceeds the desired quantity, the buyer lowers the price until the quantity for which suppliers bid equals the desired quantity. All suppliers then get to supply at this price. This auction is also referred to as the uniform-price auction.

Suppliers in either auction can raise the final price by colluding and forming a bidding ring that assigns only one bidder to enter the auction process for the entire ring. After the initial auction the ring then has a separate auction to divide up the quantity they have been assigned among themselves.

BASIC PRINCIPLES OF NEGOTIATION

In some instances, the third party that will perform a given supply chain function has been identified and the firm enters into a negotiation to set the terms of the contract. Negotiation is likely to result in a positive outcome only if the value the buyer places on outsourcing the supply chain function to this supplier is at least as large as the value the supplier places on performing the function for the buyer. The value that a supplier places on performing a function is influenced by its cost as well as other alternatives that are available for its existing capacity. Similarly, the value that the buyer places is influenced by the cost of performing the function in-house and the price available from alternative suppliers. The difference between the values of the buyer and seller is referred to as the bargaining surplus. The goal of each negotiating party is to capture as much of the bargaining surplus as possible.

An excellent discussion on negotiations is available in Thompson (2005). We mention some of the highlights from her discussion. The first recommendation is to have a clear idea of your own value and as good an estimate of the third party's value as possible. A good estimate of the bargaining surplus improves the chance of a successful outcome. Suppliers of Toyota have often mentioned that "Toyota knows our costs better than we do," which leads to better negotiations. The second recommendation is to look for a fair outcome based on

equally or equitably dividing the bargaining surplus or dividing it based on needs. Equity here refers to a division of the surplus in proportion to the contribution by each party.

The key to a successful negotiation, however, is to make it a win-win outcome. It is impossible to obtain a win-win outcome if the two parties are negotiating on a single dimension such as price. In this setting, one party can only "win" at the expense of the other. To create a win-win negotiation, the two parties have to identify more than one issue to negotiate. Identifying multiple issues allows the opportunity to expand the pie if the two parties have different preferences. This is often easier than it seems in a supply chain setting. A buyer typically cares not just about the price of performing the supply chain function but also about the responsiveness and quality (two of the dimensions identified in Table 14-3). If the supplier finds it harder to lower the price but easier to reduce the response time, there is an opportunity for a win-win resolution in which the supplier offers better responsiveness without changing the price. Thompson discusses many hurdles in the negotiation process and also suggests effective strategies.

CONTRACTS AND SUPPLY CHAIN PERFORMANCE

A supply contract specifies parameters governing the buyer-supplier relationship. In addition to making the terms of the buyer-supplier relationship explicit, contracts have significant impact on the behaviour and performance of all stages in a supply chain. Contracts should be designed to facilitate desirable supply chain outcomes and minimize actions that hurt performance. A manager should ask the following three questions when designing a supply chain contract:

1. How will the contract affect the firm's profits and total supply chain profits?

2. Will the incentives in the contract introduce any information distortion?

3. How will the contract influence supplier performance along key performance measures?

Ideally, a contract should be structured to increase the firm's profits and supply chain profits, discourage information distortion, and offer incentives to the supplier to improve performance along key dimensions. Many shortcomings in supply chain performance occur because the buyer and supplier are two different entities, each trying to optimize its own profits.

CONTRACTS FOR PRODUCT AVAILABILITY AND SUPPLY CHAIN PROFITS

Actions taken by the two parties in the supply chain often result in profits that are lower than what could be achieved if the supply chain were to coordinate its actions with a common objective of maximizing supply chain profits. Consider a product whose demand is significantly affected by the retail price. The retailer decides its price (and thus sales quantity) based on its margin. The retailer's margin is only a fraction of the supply chain margin, leading to a retail price that is higher than optimal and a sales quantity that is lower than optimal for the supply chain.

This phenomenon is referred to as double marginalization. The supplier can increase supply chain profits by offering a volume discount, where the retailer pays a lower price if the total quantity purchased exceeds a threshold.

Another example of double marginalization arises in the presence of demand uncertainty. A manufacturer wants the retailer to carry a large inventory of its product to ensure that any

surge in demand can be satisfied. The retailer, on the other hand, loses money on any unsold inventory. As a result, the retailer prefers to carry a lower level of inventory. This tension leads to a supply chain outcome that is suboptimal.

In a contract in which the supplier specifies a fixed price and the buyer decides on the quantity to be purchased, the most common cause for suboptimal supply chain performance is double marginalization. The retailer makes its buying decision before demand is realized and thus bears all the demand uncertainty. If demand is less than the retailer's inventory, the retailer has to liquidate unsold product at a discount. Given uncertain demand, the retailer decides on the purchase quantity based on its margin and the cost of overstocking. The retailer's margin, however, is lower than the contribution margin for the entire supply chain, whereas its cost of overstocking is higher than that for the entire supply chain. As a result, the retailer is conservative and aims for a lower level of product availability than is optimal for the supply chain.

Consider a music store that sells compact discs. The supplier buys (or manufactures) compact discs at $1 per unit and sells them to the music store at $5 per unit. The retailer sells each disc to the end consumer at $10. At this retail price, market demand is normally distributed, with a mean of 1,000 and a standard deviation of 300.

The retailer has a margin of $5 per disc and can potentially lose $5 for each unsold disc. Using Equation 12.1, it is optimal for the retailer to aim for a service level of 0.5 and order 1,000 discs. From Equation 12.3, the retailer's expected profits are $3,803 and the manufacturer makes $4,000 from selling 1,000 discs. For the supply chain, however, the supplier and the retailer together have a margin of $9 and can lose a maximum of only $1 per unsold disc. For the entire supply chain it is thus optimal to aim for a service level of 0.9 and stock 1,384 discs. The expected supply chain profit in this case is $8,474. The music store is thus conservative and carries fewer discs than are optimal for the supply chain. As a result, the supply chain makes $670 less than it would expect to if the retailer and the supplier worked together. To improve overall profits, the supplier must design a contract that encourages the buyer to purchase more and increase the level of product availability. This requires the supplier to share in some of the buyer's demand uncertainty. Three contracts that increase overall profits by making the supplier share some of the buyer's demand uncertainty are as follows:

1. Buyback or returns contracts
2. Revenue-sharing contracts
3. Quantity flexibility contracts

We illustrate each of the three contracts using the example of the music store and discuss their performance in terms of the three questions raised earlier.

Buyback Contracts

A buy-back or returns clause in a contract allows a retailer to return unsold inventory up to a specified amount, at an agreed-upon price. In a buyback contract, the manufacturer specifies a wholesale price c along with a buyback price b at which the retailer can return any unsold units at the end of the season. The manufacturer can salvage $sM for any units that the retailer returns.

The optimal order quantity o* for a retailer in response to a buy-back contract is evaluated, where the salvage value for the retailer is s = b. The expected profit at the manufacturer depends on the overstock at the retailer that is returned. We obtain

Expected manufacturer profit = O*(c - v) - (b - sM) X expected overstock at retailer

Revenue-Sharing Contracts

In revenue-sharing contracts, the manufacturer charges the retailer a low wholesale price c, and shares a fraction f of the retailer's revenue. Even if no returns are allowed, the lower wholesale price decreases the cost to the retailer in case of an overstock. The retailer thus increases the level of product availability resulting in higher profits for both the manufacturer and the retailer.

Assume that the manufacturer has a production cost v; the retailer charges a retail price p and can salvage any leftover units for sR. The optimal order quantity o* ordered by the retailer is evaluated, where the cost of understacking is Cu = (1 - f)p - c and the cost of overstocking is Cu = c - sR.

Expected manufacturer's profits = (c - v) o* + fp(o* - expected overstock at retailer)

Quantity Flexibility Contracts

Under quantity flexibility contracts, the manufacturer allows the retailer to change the quantity ordered after observing demand. If a retailer orders 0 units, the manufacturer commits to providing Q = (1 + α)O units, whereas the retailer is committed to buying at least q = (1 - β)0 units. Both α and β are between 0 and 1. The retailer can purchase up to Q units, depending on the demand it observes. These contracts are similar to buy-back contracts in that the manufacturer now bears some of the risk of having excess inventory. Because no returns are required, these contracts can be more effective than buy-back contracts when the cost of returns is high. Quantity flexibility contracts increase the average amount the retailer purchases and may increase total supply chain profits.

CONTRACTS TO COORDINATE SUPPLY CHAIN COSTS.

Differences in costs at the buyer and supplier also lead to decisions that increase total supply chain costs. An example is the replenishment lot size decision typically made by the buyer. The buyer decides on its optimal lot size based on its fixed cost per lot and the cost of holding inventory. The buyer does not account for the supplier's costs. If the supplier has a high fixed cost per lot, the optimal lot size for the buyer increases total cost for the supplier and the supply chain. In such a situation, the supplier can use a quantity discount contract to encourage the buyer to order in lot sizes that minimize total costs. The objective of such a contract is to encourage the retailer to buy in larger lot sizes that lower cost for the supplier and the entire supply chain.

A quantity discount contract decreases overall costs but leads to higher lot sizes and thus higher levels of inventory in the supply chain. It is typically justified only for commodity products for which the supplier has high fixed costs per lot. It is important to modify the terms of the contract as operational improvements are made at the supplier, resulting in lower fixed costs per batch.

CONTRACTS TO INCREASE AGENT EFFORT

In many supply chains, agents act on behalf of a principal and the agents' effort affects the reward for the principal. As an example, consider a car dealer (the agent) selling cars for DaimlerChrysler (the principal). The dealer also sells other brands and used cars. Every month the dealer allocates its sales effort (advertising, promotions, etc.) across all brands it sells and the used cars. Earnings for DaimlerChrysler are based on sales of its brands, which in turn are affected by the effort exerted by the dealer. Sales can be observed directly, whereas effort is hard to observe and measure. Given double marginalization, the dealer always exerts less effort than is optimal from the perspective of DaimlerChrysler and the supply chain. Thus, DaimlerChrysler must offer an incentive contract that encourages the dealer to increase effort.

In theory, a two-part tariff offers the right incentives for the dealer to exert the appropriate amount of effort. In a two-part tariff, DaimlerChrysler extracts its profits up front as a franchise fee and then sells cars to the dealer at cost. The dealer's margin is then the same as the supply chain margin, and the dealer exerts the right amount of effort.

CONTRACTS TO INDUCE PERFORMANCE IMPROVEMENT

In many instances a buyer wants performance improvement from a supplier that has little incentive to do so. A buyer with sufficient power in the supply chain may be able to force the supplier to comply. A buyer without sufficient power requires an appropriate contract to induce the supplier to improve performance. Even for a powerful buyer, however, an appropriate contract designed to encourage supplier cooperation results in a better outcome.

As an example, consider a buyer that wants the supplier to improve performance by reducing lead time for a seasonal item. This is an important component of all quick response (QR) initiatives in a supply chain. With a shorter lead time, the buyer hopes to have better forecasts and be better able to match supply and demand. Most of the work to reduce lead time has to be done by the supplier, whereas most of the benefit accrues to the buyer. In fact, the supplier will lose sales because the buyer will now carry less safety inventory because of shorter lead times and better forecasts. To induce the supplier to reduce lead time, the buyer can use a shared-savings contract, with the supplier getting a fraction of the savings that result from reducing lead time. As long as the supplier's share of the savings compensates for any effort it has to put in, its incentive will be aligned with that of the buyer, resulting in an outcome that benefits both parties.

4.3 DESIGN COLLABORATION

Two important statistics highlight the importance of design collaboration between a manufacturer and suppliers. Today, typically between 50 and 70 percent of the spending at a manufacturer is through procurement, compared to only about 20 percent several decades ago. It is generally accepted that about 80 percent of the cost of a purchased part is fixed during the design stage. Thus, it is crucial for a manufacturer to collaborate with suppliers during the design stage if product costs are to be kept low. Design collaboration can lower the cost of purchased material and also lower logistics and manufacturing costs. Design collaboration is also important for a company trying to provide a lot of variety and customization, because failure to do so can significantly raise the cost of variety.

Working with suppliers can speed up product development time significantly. This is crucial in an era when product life cycles are shrinking and bringing a product to market before the competition offers a significant competitive advantage. Finally, integrating the supplier into the design phase allows the manufacturer to focus on system integration, resulting in a higher quality product at lower cost. For example, auto manufacturers are increasingly playing the

role of system integrators rather than component designers. This is an approach that has been used even more extensively in the high-tech industry.

As suppliers take on a bigger design role, it is important for manufacturers also to become design coordinators for the supply chain. Common part descriptions should be available to all parties involved in the design, and any design changes by one party should be communicated to all suppliers affected. A good database of existing parts and designs can save significant amounts of money and time. For example, when Johnson Controls finds a seat frame from its database that fulfills all customer requirements, it saves the customer about $20 million on the design, development, tooling, and prototyping expense.

A survey by the Procurement and Supply Chain Benchmarking Consortium at Michigan State University dramatically demonstrates the impact of successfully integrating suppliers in product design. The most successful integration efforts have seen costs decrease by 20 percent, quality improve by 30 percent, and time to-market decrease by 50 percent.

Key themes that must be communicated to suppliers as they take greater responsibility for design are design for logistics and design for manufacturability. Design for logistics attempts to reduce transportation, handling, and inventory costs during distribution by taking appropriate actions during design. To reduce transportation and handling costs, the manufacturer must convey expected order sizes from retailers and the end consumer to the designer. Packages can then be designed so that transportation costs are lowered and handling is minimized.

To reduce transportation cost, packaging is kept as compact as possible and is also designed to ensure easy stacking. To reduce handling costs, package sizes are designed to minimize the need to break open a pack to fulfill an order. To reduce inventory costs, the primary approach is to design the product for postponement and mass customization. Postponement strategies aim to design a product and production process so that features that differentiate end products are introduced late in the manufacturing phase. As discussed, Dell designs its PCs so that all components about which customers have a choice are assembled after the customer order arrives.

This allows Dell to lower inventories by aggregating them as components. Mass customization strategies use a similar approach by designing the product so that inventory can be carried in a form that aggregates across multiple end products. The goal is to design a product so that customization occurs along a combination of the following three customization categories: modular, adjustable, and dimensional. To provide modular customization, the product is designed as an assembly of modules that fit together. All inventories is then maintained as modules that are assembled to order. A good example of modular customization is PC assembly at Dell. An example of adjustable customization is a washing machine designed by Matsushita that can automatically select from among 600 different cycles. All inventories is thus maintained as a single product, and each customer uses the machine to match its specific needs. An example of dimensional customization given by Josepn Pine (1999) is a machine that makes custom house gutters on site, which can then be cut to fit the dimensions of the house.

Another example is National Bicycle, which cuts the frame tubing to fit the body size of the customer. Design for manufacturability attempts to design products for ease of manufacture. Some of the key principles used include part commonality, eliminating right-hand and left-hand parts, designing symmetrical parts, combining parts, using catalog parts rather than designing a new part, and designing parts to provide access for other parts and tools.

A good area in which to view design collaboration efforts is in the automotive industry. Car manufacturers all over the world are asking suppliers to participate in every aspect of product development, from conceptual design to manufacturing. Ford, for example, asked suppliers for the Thunderbird not only to manufacture the components and subsystems, but also to be responsible for their design. Solid integration throughout the supply chain allowed Ford to bring the new model to market within 36 months of program approval.

To ensure effective communication, Ford required all its vendors to be on the same software platform for design. Ford also opened all its internal databases to its suppliers and collocated many of the suppliers at its offices. Ford engineers were in constant communication with the suppliers and helped coordinate the overall design. The result was a significant improvement in cost, time, and quality.

4.4 SOURCING PLANNING AND ANALYSIS

Periodically, each firm must analyse its procurement spending and supplier performance and use this as input for future sourcing decisions.

One important analysis is the aggregation of spending across and within categories and suppliers. Aggregation provides visibility into what a company is purchasing and from whom the product is being purchased. Managers can use this information to determine economic order quantities, volume discounts, and projected quantity discounts on future volumes.

A simple step is to consolidate spending and ensure that the firm's economic order quantity matches the supplier's economic production quantity. Managers can thus realize better economies of scale and utilize resources more effectively.

The second piece of analysis relates to supplier performance. Supplier performance should be measured against plan on all dimensions that affect total cost, such as responsiveness, lead times, on-time delivery, quality, and delivery accuracy.

Spending and supplier performance analysis should be used to decide on the portfolio of suppliers to be used and the allocation of demand among the chosen suppliers. The portfolio generally should not consist of similar suppliers. The portfolio should be constructed so that one supply source performs very well on one dimension, whereas another source performs very well on a complementary dimension.

For example, a company can source more effectively using a low-cost supplier with longer lead times along with a high-cost supplier with short lead times compared to using only one type of supplier. Similarly, one should not ignore a somewhat lower-quality source if it is much cheaper than other sources. It is also not effective to use only the cheaper but lower-quality source. It may be very effective to use the cheaper but lower-quality source along with a higherquality but more expensive source.

Once a supplier portfolio has been determined, the next question is the allocation of demand among the suppliers. The allocation should be related to the economic manufacturing quantity for each source and its cost of supply. The lowcost supplier is given large, steady orders independent of demand, whereas the flexible source is given small orders that fluctuate with demand. The flexible source has smaller economic order quantities and is better able to adjust to the fluctuations. The combination of suppliers results in a better matching of supply and demand at lower cost than using one type of supplier.

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4.5 SUPPLY CHAIN CO-ORDINATION

Supply chain coordination occurs when all stages of a supply chain work toward the objective of maximizing total supply chain profitability based on shared information. Lack of coordination can result in a significant loss of supply chain surplus.

Coordination among different stages in a supply chain requires each stage to share appropriate information with other stages. Supply chain coordination improves if all stages of the chain take actions that are aligned and increase total supply chain surplus.

Supply chain coordination requires each stage of the supply chain to share information and take into account the impact its actions have on other stages.

A lack of coordination occurs either because different stages of the supply chain have objectives that conflict or because information moving between stages is delayed and distorted.

Different stages of a supply chain may have conflicting objectives if each stage has a different owner. As a result, each stage tries to maximize its own profits, resulting in actions that often diminish total supply chain profits.

Today, supply chains consist of stages with different owners. For example, Ford Motor Company has thousands of suppliers from Goodyear to Motorola, and each of these suppliers has many suppliers in turn. Information is distorted as it moves across the supply chain because complete information is not shared between stages.

This distortion is exaggerated by the fact that supply chains today produce a large variety of products. Ford produces different models with several options for each model. The increased variety makes it difficult for Ford to coordinate information exchange with thousands of suppliers and dealers. The fundamental challenge today is for supply chains to achieve coordination in spite of multiple ownership and increased product variety.

4.6 BULL WHIP EFFECT

One outcome of the lack of supply chain coordination is the bullwhip effect, in which fluctuations in orders increase as they move up the supply chain from retailers to wholesalers to manufacturers to suppliers, as shown in Figure. The bullwhip effect distorts demand information within the supply chain, with each stage having a different estimate of what demand looks like.

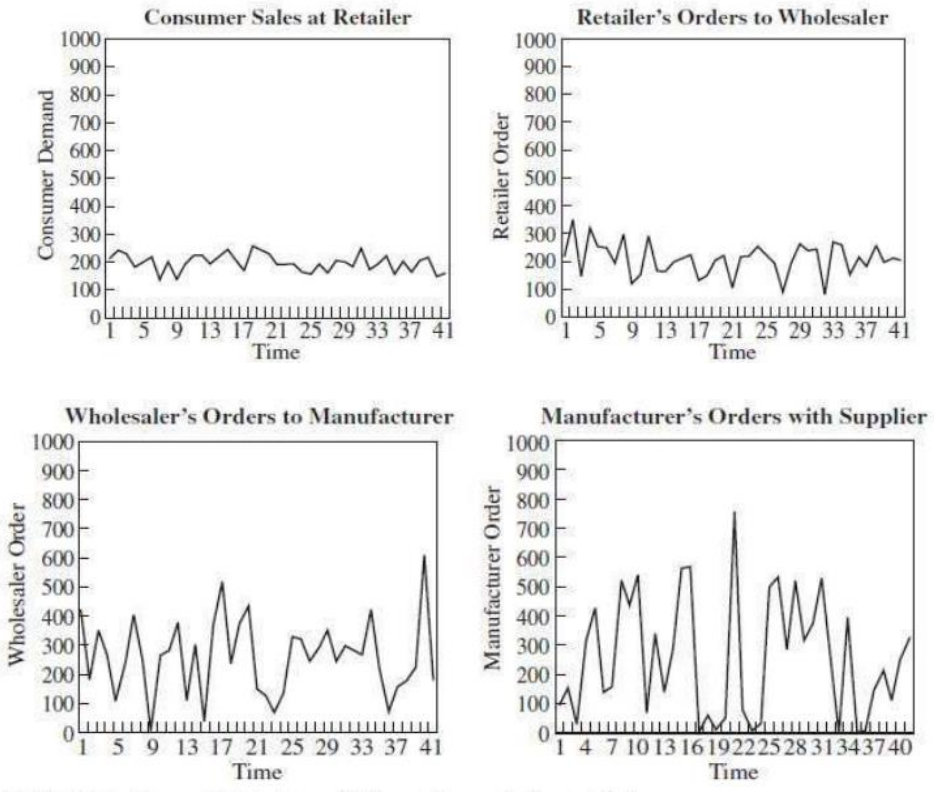

Figure 4.2 Demand Fluctuations at different stages of a Supply Chain

Procter & Gamble (P&G) has observed the bullwhip effect in the supply chain for Pampers diapers. The company found that raw material orders from P&G to its suppliers fluctuated significantly over time. Farther down the chain, when sales at retail stores were studied, the fluctuations, while present, were small. It is reasonable to assume that the consumers of diapers (babies) at the last stage of the supply chain used them at a steady rate. Although consumption of the end product was stable, orders for raw material were highly variable, increasing costs and making it difficult to match supply and demand.

HP also found that the fluctuation in orders increased significantly as they moved from the resellers up the supply chain to the printer division to the integrated circuit division. Once again, while product demand showed some variability, orders placed with the integrated circuit division were much more variable. This made it difficult for HP to fill orders on time and increased the cost of doing so.

Studies of the apparel and grocery industry have shown a similar phenomenon: The fluctuation in orders increases as we move upstream in the supply chain from retail to manufacturing.

Barilla, an Italian manufacturer of pasta, observed that weekly orders placed by a local distribution center fluctuated by up to a factor of 70 in the course of the year, whereas weekly sales at the distribution center (representing orders placed by supermarkets) fluctuated by a factor of less than three.3 Barilla was thus facing demand that was much more variable than customer demand. This led to increased inventories, poorer product availability, and a drop in profits.

A similar phenomenon, over a longer time frame, has been observed in several industries that are quite prone to “boom and bust” cycles. A good example is the production of memory

chips for personal computers. Between 1985 and 1998, at least two cycles occurred during which prices of memory chips fluctuated by a factor of more than three. These large fluctuations in price were driven by either large shortages or surpluses in capacity. The shortages were exacerbated by panic buying and over-ordering that was followed by a sudden drop in demand.

4.7 THE EFFECT ON PERFORMANCE OF LACK OF COORDINATION

A supply chain lacks coordination if each stage optimizes only its local objective, without considering the impact on the complete chain. Total supply chain profits are thus less than what could be achieved through coordination. Lack of coordination also results if information distortion occurs within the supply chain.

Manufacturing Cost

The lack of coordination increases manufacturing cost in the supply chain. As a result of the bullwhip effect, P&G and its suppliers must satisfy a stream of orders that is much more variable than customer demand. P&G can respond to the increased variability by either building excess capacity or holding excess inventory, both of which increase the manufacturing cost per unit produced.

Inventory Cost

The lack of coordination increases inventory cost in the supply chain. To handle the increased variability in demand, P&G has to carry a higher level of inventory than would be required if the supply chain were coordinated. As a result, inventory costs in the supply chain increase. The high levels of inventory also increase the warehousing space required and thus the warehousing cost incurred.

Replenishment Lead Time

Lack of coordination increases replenishment lead times in the supply chain. The increased variability as a result of the bullwhip effect makes scheduling at P&G and supplier plants much more difficult than when demand is level. There are times when the available capacity and inventory cannot supply the orders coming in. This results in higher replenishment lead times.

Transportation Cost

The lack of coordination increases transportation cost in the supply chain. The transportation requirements over time at P&G and its suppliers are correlated with the orders being filled. As a result of the bullwhip effect, transportation requirements fluctuate significantly over time. This raises transportation cost because surplus transportation capacity needs to be maintained to cover high demand periods.

Labour Cost for Shipping and Receiving

The lack of coordination increases labour costs associated with shipping and receiving in the supply chain. Labour requirements for shipping at P&G and its suppliers fluctuate with orders. A similar fluctuation occurs for the labour requirements for receiving at distributors and retailers. The various stages have the option of carrying excess labor capacity or varying labour capacity in response to the fluctuation in orders. Either option increases total labor cost.

Level of Product Availability

Lack of coordination hurts the level of product availability and results in more stockouts in the supply chain. The large fluctuations in orders make it harder for P&G to supply all

distributor and retailer orders on time. This increases the likelihood that retailers will run out of stock, resulting in lost sales for the supply chain.

Relationships across the Supply Chain

Lack of coordination has a negative effect on performance at every stage and thus hurts the relationships among different stages of the supply chain. The lack of coordination thus leads to a loss of trust among different stages of the supply chain and makes any potential coordination efforts more difficult. Lack of coordination has a significant negative impact on the supply chain's performance by increasing cost and decreasing responsiveness. The lack of coordination hurts both responsiveness and cost in a supply chain by making it more expensive to provide a given level of product availability.

Obstacles to Coordination in a Supply Chain

Any factor that leads to either local optimization by different stages of the supply chain or an increase in information delay, distortion, and variability within the supply chain is an obstacle to coordination. If managers in a supply chain are able to identify the key obstacles, they can then take suitable actions to help achieve coordination. We divide the major obstacles into five categories:

- Incentive obstacles
- Information-processing obstacles
- Operational obstacles
- Pricing obstacles
- Behavioural obstacles

1. Incentive Obstacles

Incentive obstacles occur in situations when incentives offered to different stages or participants in a supply chain lead to actions that increase variability and reduce total supply chain profits.

• Local Optimization within Functions or Stages of a Supply Chain

Incentives that focus only on the local impact of an action result in decisions that do not maximize total supply chain surplus.

If the compensation of a transportation manager at a firm is linked to the average transportation cost per unit, the manager is likely to take actions that lower transportation costs even if they increase inventory costs or hurt customer service.

It is natural for any participant in the supply chain to take actions that optimize performance measures along which they are evaluated.

• Sales Force Incentives

Improperly structured sales force incentives are a significant obstacle to coordination in a supply chain. In many firms, sales force incentives are based on the amount the sales force sells during an evaluation period of a month or quarter. The sales typically measured by a manufacturer are the quantity sold to distributors or retailers (sell-in), not the quantity sold to final customers.

2. Information-Processing Obstacles

Information-processing obstacles occur when demand information is distorted as it moves between different stages of the supply chain, leading to increased variability in orders within the supply chain.

• Forecasting Based on Orders and not Customer Demand

When stages within a supply chain make forecasts that are based on orders they receive, any variability in customer demand is magnified as orders move up the supply chain to manufacturers and suppliers. In supply chains where the fundamental means of communication among different stages are the orders that are placed, information is distorted as it moves up the supply chain. A small change in customer demand becomes magnified as it moves up the supply chain in the form of customer orders. The retailer may interpret part of this random increase as a growth trend.

This interpretation will lead the retailer to order more than the observed increase in demand because the retailer expects growth to continue into the future and thus orders to cover for future anticipated growth. The increase in the order placed with the wholesaler is thus larger than the observed increase in demand at the retailer. The growth trend inferred by the wholesaler will be larger than that inferred by the retailer. The wholesaler will thus place an even larger order with the manufacturer.

• Lack of Information Sharing

The lack of information sharing between stages of the supply chain magnifies the information distortion. A retailer such as Wal-Mart may increase the size of a particular order because of a planned promotion. If the manufacturer is not aware of the planned promotion, it may interpret the larger order as a permanent increase in demand and place orders with suppliers accordingly. The manufacturer and suppliers thus have much inventory right after Wal-Mart finishes its promotion.

3. Operational Obstacles

Operational obstacles occur when actions taken in the course of placing and filling orders lead to an increase in variability.

• Ordering in Large Lots

When a firm places orders in lot sizes that are much larger than those in which demand arises, variability of orders is magnified up the supply chain. Firms may order in large lots because a significant fixed cost is associated with placing, receiving, or transporting an order. Large lots may also occur if the supplier offers quantity discounts based on lot size. Figure shows both the demand and the order stream for a firm that places an order every five weeks. Manufacturer supplying several retailers that batch their orders faces an order stream that is much more variable than the demand the retailers experience. If the manufacturer batches its orders to suppliers, the effect is further magnified.

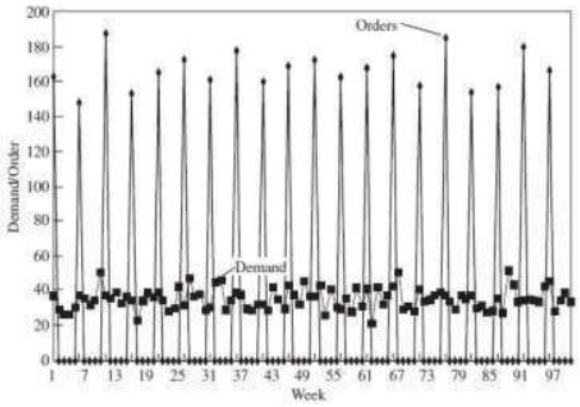

Figure Demand and Order Stream with Orders Every Five Weeks

• Large Replenishment Lead Times

Information distortion is magnified if replenishment lead times between stages are long. Consider a situation in which a retailer has misinterpreted a random increase in demand as a growth trend. If the retailer faces a lead time of two weeks, it will incorporate the anticipated growth over two weeks when placing the order. In contrast, if the retailer faces a lead time of two months, it will incorporate into its order the anticipated growth over two months.

• Rationing and Shortage Gaming Rationing schemes that allocate limited production in proportion to the orders placed by retailers lead to a magnification of information distortion. This can occur when a high-demand product is in short supply. In such a situation, manufacturers come up with a variety of mechanisms to ration the scarce supply of product among various distributors or retailers. One commonly used rationing scheme is to allocate the available supply of product based on orders placed. Under this rationing scheme, if the supply available is 75 percent of the total orders received, each retailer receives 75 percent of its order. If the manufacturer is using orders to forecast future demand, it will interpret the increase in orders as an increase in demand even though customer demand is unchanged. The manufacturer may respond by building enough capacity to be able to fill all orders received. Once sufficient capacity becomes available, orders return to their normal level because they were inflated in response to the rationing scheme.

4. Pricing Obstacles

Pricing obstacles arise when the pricing policies for a product lead to an increase in variability of orders placed.

• Lot Size–Based Quantity Discounts

Lot size–based quantity discounts increase the lot size of orders placed within the supply chain because lower prices are offered for larger lots.

• Price Fluctuations

Trade promotions and other short-term discounts offered by a manufacturer result in forward buying, by which a wholesaler or retailer purchases large lots during the discounting period to cover demand during future periods. Forward buying results in large orders during the promotion period followed by very small orders. Observe that the shipments during the peak period are higher than the sales during the peak period because of a promotion offered.

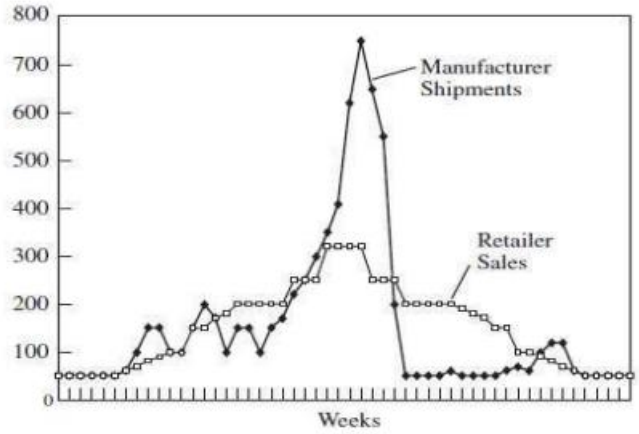

Figure 4.3 Retailer Sales and Manufacturer Shipments

5. Behavioural Obstacles

Behavioural obstacles are problems in learning within organizations that contribute to information distortion. These problems are often related to the way the supply chain is structured and the communications among different stages. Some of the behavioral obstacles are as follows:

1. Each stage of the supply chain views its actions locally and is unable to see the impact of its actions on other stages.

2. Different stages of the supply chain react to the current local situation rather than trying to identify the root causes.

3. Based on local analysis, different stages of the supply chain blame one another for the fluctuations, with successive stages in the supply chain becoming enemies rather than partners.

4. No stage of the supply chain learns from its actions over time because the most significant consequences of the actions any one stage takes occur elsewhere.

5. A lack of trust among supply chain partners causes them to be opportunistic at the expense of overall supply chain performance. The lack of trust also results in significant duplication of effort.

4.8 BUILDING STRATEGIC PARTNERSHIPS AND TRUST

Sharing of accurate information that is trusted by every stage results in a better matching of supply and demand throughout the supply chain and a lower cost. A better relationship also tends to lower the transaction cost between supply chain stages. For example, a supplier can eliminate its forecasting effort if it trusts orders and forecast information received from the retailer. Similarly, the retailer can lessen the receiving effort by decreasing counting and inspections if it trusts the supplier's quality and delivery. In general, stages in a supply chain can eliminate duplicated effort on the basis of improved trust and a better relationship. This lowering of transaction cost along with accurate shared information helps improve coordination. Wal-Mart and P&G have been trying to build a strategic partnership that will better coordinate their actions and be mutually beneficial.

In general, a high level of trust allows a supply chain to become more responsive at lower cost. Actions such as information sharing, changing of incentives, operational improvements, and stabilization of pricing typically help improve the level of trust. Growing the level of cooperation and trust within a supply chain requires a clear identification of roles and decision rights for all parties, effective contracts, and good conflict resolution mechanisms.

Cooperation and trust within the supply chain help improve performance for the following reasons:

- When stages trust each other, they are more likely to take the other party's objectives into consideration when making decisions, thereby facilitating winwin situations.
- Action-oriented managerial levers to achieve coordination become easier to implement and the supply chain becomes more agile.
- An increase in supply chain productivity results, either by elimination of duplicated effort or by allocating effort to the appropriate stage.
- Detailed sales and production information is shared; this allows the supply chain to coordinate production and distribution decisions.