DESIGNING AND MANAGING THE SUPPLY CHAIN

Solutions for Discussion Questions[1]

[1]

CHAPTER 1
INTRODUCTION TO SUPPLY CHAIN MANAGEMENT

Chapter Overview

This chapter introduces supply chain management (SCM) and describes how supply chain management is critical in today's global business. Supply chain management is described as a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirements.

It is important to understand the basic issues underlying SCM and the challenges facing companies to achieve effective management of their supply chains. Various issues and factors are described in this chapter. Specifically, the concept of managing risk and uncertainty, global optimization, relationship of the supply chain to the development chain are discussed. The chapter also discussed how the area evolved through the years. The primary purpose of this chapter is to establish a context for SCM in the realm of globalization and to instill this sense of importance in the students. If you've accomplished that by the end of the chapter, you've established a solid foundation for the remainder of the course.

Discussion Questions

Question 1

Pick any car model manufactured by a domestic auto maker. For example, consider the 2002 Ford Thunderbird.

a. The supply chain for a car typically includes the following components::

1. Suppliers for raw materials
2. Suppliers for parts and subsystems
3. Automobile manufacturer (Ford, in the example). Within a company, there are also different departments, which constitute the internal supply chain:
    i. Purchasing and material handling
    ii. Manufacturing
    iii. Marketing, etc.
4. Transportation providers
5. Automobile dealers

b. Many firms are involved in the supply chain.

1. Raw material suppliers. For instance, suppliers for steel, rubber, plastics, etc.
2. Parts suppliers. For instance, suppliers for engines, steering wheels, seats, and electronic components, etc.
3. Automobile manufacturer. For instance, Ford.
4. Transportation providers. For instance, shippers, trucking companies, railroads, etc.
5. Automobile dealers. For instance, Hayward Ford.

c. All companies involved in the supply chain want to maximize their respective profits by increasing revenue and decreasing cost. However, companies may employ different strategies in order to achieve this goal. Some of them focus on customer satisfaction and quick delivery, while others may be more concerned about minimizing inventory holding costs.

d. In general, different parts of the supply chain have objectives that are not aligned with each other.

1. Purchasing: Stable order quantities, flexible delivery lead times and little variation in mix.
2. Manufacturing: Long production runs, high quality, high productivity and low production costs.
3. Warehousing: Low inventory, reduced transportation costs and quick replenishment capability.
4. Customers: Short order lead times, a large variety of products and low prices.

Typically, the automobile dealer would like to offer a variety of car colors and configurations to accommodate different customer preferences, and meanwhile have a short delivery lead time from the manufacturer. However, in order to maximize the length of production runs, and utilize resources more efficiently, the manufacturer would like to aggregate orders from different dealers and offer less variety in car configurations. This is a clear example of conflicting marketing and manufacturing goals.

Question 2

a. The supply chain for a consumer mortgage offered by a bank may involve various components.

1. Marketing companies that handle solicitation to potential customers.
2. Credit reporting agencies that evaluate potential customers.
3. The bank that extends the mortgage loans.
4. Mortgage brokers through which the loans are distributed.

b. The marketing companies strive to increase the response rate from homebuyers in order to maximize their returns. Banks aim at a customer portfolio with a relatively low risk, healthy flow of payments and low average loan maturity date. The brokers would like to maximize their sales commissions.

c. Similar to product supply chains, the objective of a service supply chain is to provide what is needed (in this case, a particular type of service, rather than a physical product) at the right location, at the right time, and in a form that conforms to customer requirements while minimizing systemwide costs. However, there are a number of differences between the two types of supply chains. For instance:

1. In a product supply chain, there is both a flow of information and physical products. In a service supply chain, it is primarily information.
2. Contrary to a service supply chain, transportation and inventory are major cost components in a product supply chain.
3. Services typically cannot be held in inventory, so matching capacity with demand is frequently more important in a service supply chain.
4. In a service supply chain, the (explicit) cost of information is higher than in a product supply chain. Note that in the mortgage example above, the bank has to compensate the credit reporting agency for each credit report it obtains.

Question 3

Many supply chains evolve over time. For example, consider a memory chip supply chain. Production strategies may change during different stages of the product life cycle. When a new memory chip is introduced,

price is high, yield is low, and production capacity is tight, and the availability of the product is important. Consequently, production is usually done at plants close to markets, and the management focuses on increasing yield, reducing the number of production disruptions, and fully utilizing capacity. When the product matures, however, its price drops and demand is stabilized for a period of time, so minimizing production cost moves to center stage. To reduce costs, production may be outsourced to overseas foundries, where labor and materials are much cheaper.

Question 4

A vertically integrated company aims at tighter interaction among various business components, and frequently manages them centrally. Such a structure helps to achieve systemwide goals more easily by removing conflicts among different parts of the supply chain through central decision making. In a horizontally integrated company, there is frequently no benefit in coordinating the supply chains of each business within the company. Indeed, if every business specializes in its core function, and operates optimally, an overall global optimum may be approached.

Question 5

Effective supply chain management is also important for vertically integrated companies. In such an organizational structure, various business functions are handled by different departments of the company that usually have different internal objectives, and these objectives are not necessarily aligned with each other. This may be due to lack of communication among departments or the incentives provided by the upper management. For instance, if the sales department is evaluated based on revenue only, and the manufacturing department is evaluated based on revenue only, and the manufacturing department is evaluated based on cost only, the company's profit may not be maximized globally. Effective supply chain management is still necessary to achieve globally optimal operations.

Question 6

The sources of uncertainty in this example include:

1. Factors such as weather conditions, diseases, natural disasters cause uncertainty in availability of raw materials, i.e., peach crop.

2. Uncertain lead times during transportation of crop from the field to the processing facility may affect the quality of peaches, e.g., they may get spoiled.

3. Processing times in the plant, as well as the subsequent warehousing and transportation times are subject to uncertainty.

4. Demand is not known in advance.

Question 7

A small number of centrally located warehouses allows a firm to take advantage of risk pooling in order to increase service levels and decrease inventory levels and costs. However, outbound transportation cost is typically higher, and delivery lead times are longer. On the other hand, by building a larger number of warehouses closer to the end customers, a firm can decrease outbound transportation costs and delivery lead times. However, this type of system will have increased total inventory levels and costs, decreased economies of scale, increases warehousing expenses, and potentially increased inbound transportation expenses.

Question 8

The choice of the particular transportation service depends largely on the types and sizes of products the company wants to transport, the inventory and delivery strategies and the need for flexibility:

1. A truckload carrier is better if delivering bulky items or small items in large and stable quantities from warehouses to demand points (stores). A good example is the delivery of groceries from warehouses to supermarkets. Note that in this case we would like the demand to be in increments of full truck loads.

2. A package delivery firm is more appropriate if relatively small items are delivered from the manufacturer/warehouse directly to the customers. Additionally, a package carrier company offers more flexibility by different modes of transportation depending on the needs of the individual customers.

Question 9

1. High inventory levels

    i. Advantages: High fill rate (service level) and quick order fulfillment.
    ii. Disadvantages: High opportunity cost of capital tied in inventory, danger of price declines over time and obsolescence, need for more warehouse space.

2. Low inventory levels

    i. Advantages: Low inventory holding and warehousing costs.
    ii. Disadvantages: Higher risk of shortages and lower service levels.

Question 10

Building redundancy into the supply chain means that if one portion fails, the supply chain can still satisfy demand. This is the biggest advantage of building redundancy in the supply chain. Alternate sources of supply, provision for alternate transportation and distribution modes, alternate warehouses are some of the ways by which redundancy can be built. A disadvantage of this policy is that excess capacity is built into the system in order to hedge against emergencies that may disrupt the supply – if these capacities are not used over time and if too much capacity is built as redundant capacity, the costs to the supply chain increases.

Other ways by which redundancy can be built is by using information to better sense and respond to disruptive events, incorporating flexibility into supply contracts to better match supply and demand and improving supply chain processes by including risk assessment measures

Question 11

Inefficiencies in distributing products from the factories to the customers is primary reason why both costs have increased. The two are related as the longer the time it takes to move products from one point to the next in the supply chain, the higher will be the transportation costs – in addition, the inventory costs will be higher as more products would be stocked in the pipeline between the suppliers and the customers.

CASE: Meditech Surgical

Question 1

Meditech experiences poor service levels for new products, and inventory levels higher than necessary for all products.

Question 2

There are many causes for these problems:

1. Demand is not studied in detail.
2. Information systems that record and monitor demand and inventory are poorly designed.
3. Forecasting errors are not tracked.
4. There is a tendency to shift the blame to the customers, e.g., panic ordering.
5. There are built-in delays and monthly buckets in the planning system.
6. The planning system amplifies small variations in demand.
7. Poor communication with customers; Meditech doesn't typically see end-customer demand.

Question 3

The customer service manager is directly exposed to the complaints from the customers. Hence, he is in a good position to gauge the scope of the problems. Other managers do not face the customers, and they do not necessarily focus on their satisfaction.

Question 4

1. Recognize that demand is predictable, and establish better forecasting systems and accountability for forecasts.
2. Institute better planning systems to eliminate planning delays; reduce the size of system time buckets.
3. Alternatively, put assembly within the pull system and eliminate bulk inventory completely.
4. Develop and implement better information systems.
5. Improve communications with customers.

CHAPTER 2
INVENTORY MANAGEMENT AND RISK POOLING

Chapter Overview

In this chapter, issues related to managing inventory in various stages of the supply chain are discussed. Specifically the following points are reviewed in the chapter. Strategies related to how firms cope with huge variability in customer demand are discussed. The relationship between service levels and how much inventory to carry is important. In addition, the effect of lead time and the variability in lead time has an effect on the inventory levels. Finally, different inventory policies are discussed – the policies differ with respect to the different scenarios that may be present for a particular item or a specific partnership between two firms.

CASE: Steel Works, Inc.

Please see the chapter's PowerPoint presentation for case discussion.

Discussion Questions

Question 1

Refer to PowerPoint slides on Steel Works case

Question 2

Companies can cope with uncertainty by

1. keeping safety stock,
2. shortening production and order lead times,
3. using risk pooling strategies,
4. delaying product differentiation in the supply chain as much as possible, i.e., aggregating demand for parties upstream of the supply chain, and
5. by installing systems to achieve information sharing between suppliers and buyers, thus enabling collaborative demand forecasting.

Question 3

In general, higher inventory levels make it easier to maintain higher service levels. However, modern inventory management techniques may make it possible to increase service levels without increasing inventory levels as much as in the past.

Question 4

The variability in demand increases as the average and the variance of lead time increase. Therefore, for a given service level, inventory levels increase with longer lead times and higher lead time variance.

Question 5

The target service level depends on the mission-criticality of the product. For instance, consider a service parts vendor for equipment for which every hour of down time is very expensive. In this case, we would expect the management of the vendor company to specify a service level close to 100%.

Market conditions also play an important role in determining target service levels. For commodities, we would expect relatively high service levels since customers can switch products easily if they do not find the particular product they look for. However, a lower service level may be acceptable if the product has a clear value differentiation compared to its competitors. For instance, customers of a high-end server that is clearly deemed superior to the rest of the market may be willing to wait for 1-2 weeks if the manufacturer is out-of-stock.

Question 6

The reorder level **s = L * AVG + z * STD** * $\sqrt{L}$ has two components. The first component **L * AVG** covers the expected demand during lead time, and the second component **z * STD** * $\sqrt{L}$ is safety stock that protects against deviations from the expected demand during lead time. Therefore, immediately before the order arrives, we expect that the first component is depleted completely and the inventory level is **z * STD** * $\sqrt{L}$. Then, when an order of **Q** units arrives, the expected level of inventory is **Q + z * STD** * $\sqrt{L}$.

Question 7

In the base-stock policy, at the time the warehouse places an order, this order raises the **inventory position** to the base-stock level **(r + L) * AVG + z * STD** * $\sqrt{r + L}$. Similar to the reorder level **s** in the continuous review policy discussed in Question 5, this base-stock includes two components: the average demand **(r + L) * AVG** until the order arrives after **r + L** periods, and the safety stock **z * STD** * $\sqrt{r + L}$ that protects against demand uncertainty during lead time. Thus, just before an order arrives, the expected inventory on have is equal to the safety stock **z * STD** * $\sqrt{r + L}$.

In order to determine the expected inventory level right after an order arrives at time **t + L**, note that when inventory is reviewed at time **t**, the **inventory position** is raised to the base-stock level, and an order that was placed at time **t - r** arrives at time **t + L**. (See Figure 3-12.) Therefore, when an order arrives, the expected inventory level is **L * AVG** units less than the base-stock level, i.e., is equal to **r * AVG + z * STD** * $\sqrt{r + L}$.

Question 8

Possible items for discussion are as follows:

1. Magazines – order quantity has to be the average demand for a magazine that the store expects to sell. The service level is low and the store would not order a large quantity as unsold magazines would be worthless

2. BestSellers – order quantity would be slightly higher than average demand as the store can expect higher than average demand for such books
3. CDs – order quantity would be higher than average demand for the titles where the store expects a higher demand. Otherwise the service level will be low for infrequently sold CDs.
4. Potato Chips – order quantity typically would cover expected demand over a number of days. Store needs a high service level for such items and the longer shelf life of the products allows a larger order quantity.
5. Milk – service level is high and hence order quantity would have to meet a high percentage of expected demand; although milk is perishable, this is managed through frequent deliveries, which allows the store to only match demand with available inventory over a few days.

Question 9

Observe that the longer L_1, the more time the system has before allocation of inventory to the retailers need to be made by the cross-dock facility. Thus, the longer L_1 the more the system can take advantage of the risk pooling concept. Hence, the total amount of inventory is smaller when the cross dock facility is closer to the retail outlet.

Question 10

The answer is not immediately clear because the required safety stock depends both on the average and on the variance of the lead-time. The retailer would have to make a decision depending on the relative effects of these two factors. In addition, your decision would ultimately depend on the requirements of the retailer's customers.

Question 11

For a mature product, it is reasonable to expect that the price and demand are stable in the short term. However, as the time horizon gets longer, and new products are introduced into the market, the demand and price for this particular product decrease and excessive inventories may have to be written off. Thus, inventory holding costs related to obsolescence may be regarded as fixed in the short term, but not in the long term.

Some storage costs are another example of inventory related costs fixed in the short term, but variable in the long term. For instance, due to large inventories as company may have to rent multiple warehouses for a fixed lease term. However, if inventory policies are improved and turnover rates are increased in this period of time, then it may be possible to rent fewer warehouses when renewing the lease contracts. Clearly, similar arguments can be made for material handling equipment, storage racks, insurance, personnel, etc.

Question 12

Such deterministic models can be used as proxies for the more realistic stochastic models if the planning horizon is short, and the parameters of the problem are expected to be relatively stable over this time frame. However, most importantly, simple models can illustrate the basic trade-offs in a given type of problem which also translate into more realistic and complex situations. For instance,

the optimal policy for the **economic lot sizing** model balances ordering and inventory holding costs which is a general insight for more sophisticated systems as well.

Question 13

There are implicit and explicit penalties associated with a highly variable demand. For instance:

1. As discussed, the level of safety stock is proportional to the variability in demand, i.e., the higher the variability in demand the higher the inventory holding costs.

2. From a manufacturer's perspective, highly variable demand means that utilization of equipment will greatly fluctuate, and equipment will sit idle when demand is low.

3. From a managerial perspective, high variability makes planning a very complex task that requires additional resources, sophisticated models and tools.

On the other hand, if a company is successful at implementing strategies to cope with high variability in demand, it may be possible to leverage on these to increase market share and/or revenue if the competitors are not as successful.

Question 14

a. Risk pooling across locations: combining several warehouses into a single central warehouse.

b. Risk pooling across time: using quarterly demand forecasts instead of monthly forecasts to do capacity planning.

c. Risk pooling across products: designing products with maximum commonality and delaying product differentiation in the supply chain as much as possible.

Question 15

If pricing strategies, service levels and quality of service in two stores are similar, then we would expect the demand in these two stores to be positively correlated. However, assume that while the overall market demand is relatively stable, one of the stores is running a promotion. In this case, we would expect that the promotional campaign would steal sales from the other store, so that the demand in the two stores would be negatively correlated.

Question 16

In the absence of historical data, judgment and market research methods would be most useful at the beginning of the life cycle of the first Sony Walkman™. As more data becomes available during the product adoption phase, time-series methods could be employed successfully. Then, as the product matures and the manufacturer has a better understanding of the factors that affect demand, both time-series and causal methods could prove effective.

When introducing a more recent Walkman model, we would expect Sony to rely much less on judgment and market research methods compared to the very first model. Years of experience, knowledge and data can be used to develop accurate quantitative time-series and causal models.

Question 17

a. The benefits of risk pooling increase as the correlation between demands decrease. Therefore, similarity of demand across the five regions makes the proposed system less appealing.

b. The total cost of the decentralized system is $9,272 per week. In the centralized system, LA is the best location with the total cost of $6,545 per week. Please refer to the attached spreadsheet "Chapter_2_Question_17.xls" for details.

c. In this case, the minimum total cost is $8,808 per week, and the central warehouse is located in LA. In other words, the decrease in the inventory holding costs due to the decreased lead time between the manufacturing facility and the warehouse is more than offset by the increase in the transportation costs. Please refer to the attached spreadsheet "Chapter_2_Question_17.xls" for details.

Case: Sport Obermeyer

Please refer to "Harvard Case Notes: Sport Obermeyer Ltd., Teaching Note (5-696-012) 31p, Janice H. Hammond, Ananth Raman" for solutions of the case discussion questions.