Supply Chain Reengineering: Improving Inventory Management and Customer Service Quality

by

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Companies competing in today's global economy are challenged by two critical yet conflicting issues related to their supply chains. On one hand, they are under ongoing pressure to reduce operational and inventory costs, which requires keeping inventory levels low. On the other hand, they must achieve a high customer service level by having inventory available when and where the customer wants it. To achieve these conflicting goals requires supply chain reengineering for many organizations.

This article focuses on a study that was conducted at a major manufacturer of orthopedic products (XYZ Company) that faced this challenging problem. Primary objectives of this study were to reduce the level of field inventory while simultaneously improving the customer service level.

The goals of reducing inventory and improving customer fulfillment are each individually challenging for businesses. When attempting to achieve both of these simultaneously, the difficulty is magnified by the disparate nature of the goals. However, supply chain reengineering allows taking a holistic approach (Handfield and Nichols, 1999). This strategy simultaneously considers improvements in materials management, manufacturing, marketing, distribution, and logistics processes within a company and its chain of suppliers and customers (Leenders and Fearon, 1997; Flickinger and Baker, 1995; and Tayur, Ganeshan, and Magazine, 1999).

To address this problem for the orthopedic products manufacturer studied here, a new and effective distribution system and new inventory management strategies are offered. Specifically, a spreadsheet-based decision support system is introduced to determine the minimal inventory levels necessary to support the selected customer service level. Service level is defined as the probability that a customer demand can be immediately fulfilled from the stock on hand (Amini and Retzlaff-Roberts, 1999). For example, a 95% service level means that 95% of customer demands can be fulfilled and the remaining five percent of customer demands experience a delay due to stock-outs.

A regional study of the company's North American operations is underway. Following process improvements produced by the pilot study, the company foresees a complete implementation of the distribution system and inventory management strategies within the North American market. The new processes are expected to produce significant direct savings in distribution and inventory costs.

Background

XYZ Company is a major global manufacturer of orthopedic and other healthcare products. It has approximately 12,000 employees and operates in more than 35 countries. Global sales are in excess of $1.5 billion annually. XYZ is
deeply involved in research and development to continuously create and introduce new products that push the envelope of healthcare. This study focuses specifically on their orthopedic product line within the U.S.

XYZ manufactures and promotes these products. Independent regional distributors provide the sales and final distribution portion of the business. Distributors hold the finished product inventory in their own facilities. When a surgery is scheduled involving XYZ’s products, the distributor generally provides the necessary item to the hospital from their stock on hand, often with the salesperson making the delivery in person.

The market of orthopedic products has been growing steadily within North America. Currently 38% of the U.S. population is 50 years old or older, and this percentage is increasing. Similar growth is expected worldwide.

There are five characteristics that are specific to the orthopedic industry, which create a unique and competitive environment:

1. Unique customers (orthopedic surgeons),
2. Degree of customer support expected,
3. Wide array of products,
4. Accompanying surgical instruments, and
5. Inventory is provided to distributors on a consignment basis.

The first unique characteristic is that, while the end-users of orthopedic products are the patients, the customer who selects which orthopedic manufacturer to use is the surgeon. Consequently products are marketed to physicians, not to the general public as consumer products traditionally are. It is important for sales personnel to have a good rapport with the surgeon to create brand loyalty. The orthopedic surgeons are known to be among the most demanding customers to satisfy. They are also the ones who specify the time and location of surgery.

The second unique characteristic is that sales people do more than just sell. They provide an unusually high level of extended customer support. For example, the salesperson is often present in the operating room to assist a surgeon with the procedure, product selection, and the use of instruments.

Third, due to variations in the physical characteristics of patients, a full range of implants in different sizes must be available during surgery. It is absolutely crucial, once surgery has begun, that the correct implant in the correct size is available and in a sterile condition. To make matters more complex, having a full range of sizes alone is not sufficient. There must also be a back up set to allow for the possibility of an implant being dropped, damaged, or becoming unsterile. As a result, the number of implants that are actually used — and hence purchased — is only a small portion of the number that must be shipped. Unused implants are returned.

Fourth, surgical instruments are designed and produced specifically for the implants. So when a “kit” is prepared for a given surgery, it contains not only the array of implants discussed above, but also the accompanying required set of surgical instruments. These instruments are also returned along with the unused implants.

Fifth, the fact that inventory is provided on consignment to the independent distributors often results in the distributors carrying more inventory than required because there is little cost associated with doing so. In addition, XYZ experienced some stock-out problems and for a period of time had a service level as low as 80 percent. This motivated distributors to increase their inventory levels further.

These characteristics taken together create a situation with excessive levels of field inventory and complicated the forward and reverse logistics. These logistics involve (1) shipment of products and instrumentation; (2) processing the returned unused products and surgical instruments; and (3) minute-by-minute scheduling of technical
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Support due to common changes in surgery schedules. These unique characteristics create a business environment with high inventory and operational costs and consequently low margins—a tough competitive marketplace. Meanwhile, it provides a significant opportunity for improvement from supply chain reengineering.

Reengineering the Supply Chain

XYZ utilizes regional marketing structure to serve independent distributors of orthopedic products and hospitals in North America. There are wide variations among the independent regional distributors. They vary from small distributors carrying and marketing products as a secondary “backdoor” business to distributors that are dedicated to the specific lines of products manufactured by the XYZ company, managing their own sales and marketing groups, and generating significant revenue. Also, the degree of dedication to XYZ Company’s products varies among the distributors. Some only carry XYZ’s line of products, while others might also market competitor’s products as well.

Orthopedic products and surgical instruments used for a given surgery can be provided by the independent distributor or directly through a central replenishment distribution center (DC) operated by the XYZ Company. Also, the central DC is in charge of replenishment of products and surgical instruments for the North American distribution network. Figure 1 depicts the current North American supply chain. The arrows indicate the possible flow of products and surgical instruments throughout the chain. The forward logistics process is depicted by the forward arrows and the reverse logistics process is shown by backward arrows.

The issue, which precipitated consideration of supply chain reengineering, is that the carrying costs associated with high levels of inventory were continuously narrowing the margin, while at the same time service levels needed improvement (Amini and Retzlaff-Roberts, 1999b). This called for an integrative overhaul of the entire supply chain. The new supply chain must enhance the customer service quality as measured by the availability of products and surgical instruments where and when needed. This must recognize a two-tier customer structure: distributors as immediate customers and surgeons and hospitals as final customers. The improvement is measured by the reduction of annual total inventory and logistics costs.

Consolidation of Distribution Centers

The study concluded that there are two major qualitative considerations in reengineering the supply chain. The first is creation and consolidation of distribution centers. With regard to the regional DCs, there were two strategies to
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consider: either create new DCs within each region or select a subset of current distributors within the North American market to utilize as regional distribution DCs. The capital and operational costs associated with the first choice are significant, making the second choice more attractive. If a suitable distributor were available in a given area, the distributor would be utilized. The qualitative and quantitative criteria applied in the distributor selection process are as follows: (1) the quality and size of the existing distributors organization; (2) the current and potential future business volume generated by the distributor; (3) the quality of the current and past relationships between XYZ and distributor; (4) distributor’s degree of dedication to the line of products offered by XYZ company; and (5) current geographic location of the distributors and the future regional demand growth.

By utilizing regional distribution centers (RDCs) the shipping distances would be kept relatively short, allowing XYZ to take advantage of distance based pricing offered by their carrier. Based on the geographic location of customers, a set of locations was identified for the RDCs. This was done by developing a map showing the locations and volume density of customers. Mutually exclusive regions were then identified where a significant volume of business would lie within a fixed radius of the RDC. This allows shipments from the RDC to be both fast and economical. The RDC locations were also selected in a manner which minimized the total number of RDCs while providing required coverage (Amini and Retzlaff-Roberts, 1999).

Each of the selected RDCs will be expected to support the distributors and hospitals within a specified area in the forward and reverse logistics process including the necessary technical services. The current central DC would replenish the RDCs. Figure 2 depicts the flow of products and surgical instruments within the new supply chain.

By maintaining an adequate inventory level at the RDCs, the service level is high and customers receive shipments quickly. A slower and less expensive mode of shipping can be utilized for replenishment shipments from the central DC. This also allows consolidation of replenishment shipments, as opposed to shipping kits from the central DC to individual surgeries.

Consolidation of Independent Distributors

The second consideration in supply chain reengineering has been to consolidate “smaller” independent distributors within each region. The two factors used to select distributors for consolidation purposes are current sales volume and projected future volume. This strategy includes a variety of options, from cancellation of distribution contracts to consolidation of inventory locations and voluntary cooperation among smaller distributors within a given region.

![Figure 2: Reengineered Supply Chain of Orthopedic Products at the XYZ Company](image-url)
**Managing Inventory in the Supply Chain**

Structural changes in a given supply chain alone would not be sufficient for effective inventory management. The uncertainties that exist throughout the chain in response to variations in demand for orthopedic products and surgical instruments must be recognized and properly managed. Assisting XYZ Company in managing demand fluctuations requires utilization of sophisticated inventory management methods and tools. For a given inventory item, such tools provide management with (1) the stock-up-to-levels for different service levels, and (2) the associated annual total inventory costs (Retzlaff-Roberts and Amini, 1998).

To ensure ease of application, a spreadsheet-based decision support aid was created. The purpose of the decision aid is to provide management at the central DC, the new RDCs, and the independent distributors with consistent information. This information includes an inventory item’s (1) stock-up-to-level for a selected service level, and (2) the total inventory costs of the selected stock-up-to-level and its associated degree of customer service quality. Use of the new decision aid at every inventory location throughout the chain would provide management with common performance measurements for benchmarking purposes. It would also allow, for the first time, development of inventory controls that define the trade off between inventory costs and service level. Finally it would introduce adequate flexibility in applying market- and inventory-item specific information to determine necessary stock-up-to-levels, rather than having a “one-size-fits-all” inventory management policy.

The decision aid includes two models. The first model determines the stock-up-to-level for inventory items as follows. With input of an inventory item at an inventory location along with the demand distribution and lead-time distribution, the decision aid allows managers to perform “what-if” analysis and identify the probability of a stock-out based on an array of stocking levels. The user can select a given service level and look up the appropriate stock-up-to-level in the information table generated by the decision aid.

The second model within the decision aid assists management in determining the total annual costs of an inventory item considering customer service quality and related stocking levels. In calculating the total annual inventory cost for a given item, the decision aid takes into account relevant inventory carrying costs. Both fixed and variable costs associated with holding inventory are addressed. When the set of information generated by the first model for a given inventory item along with the cost information is input, total annual inventory costs are calculated.

The decision aid is designed for management within XYZ Company, DCs, and independent distributors to use for scenario analysis purposes. As changes in cost structure, demand, and expected service level are realized, the decision aid has the flexibility to adjust. Thus, it is capable of assisting management in investigating a host of possible scenarios to identify the most effective approach to inventory management. Also, it provides an opportunity for the company to more effectively communicate the current and future issues related to inventory management objectively. In addition, use of the decision aid throughout the supply chain facilitates benchmarking, identification of the best practices, and, consequently, determination of improvement opportunities to further reduce costs and enhance customer service quality.

Currently a regional pilot study of the new supply chain structure and the decision aid are underway...
Within one of the regions in the North American market, the purpose of the pilot study is to evaluate the effectiveness of the use of regional distribution centers. Evaluation will include (1) improvements in customer service quality, (2) savings in total logistics costs, (3) reduction in the current inventory level throughout the supply chain and the associated inventory carrying costs, and (4) reduction of cycle times related to the distribution and replenishment processes. The company intends to introduce modifications as required by the pilot study. The final plan is to implement the newly reengineered supply chain structure along with the decision aid across the entire North American market.

Conclusions

In dealing with the pervasive and complex problem of keeping inventory levels low and customer service high, optimization of individual links in the supply chain is not likely to produce an optimal solution for the overall supply chain. Taking a holistic approach by using supply reengineering can improve results for all parties involved and address such disparate goals as low inventory and high customer service. The experiences of XYZ Company presented in this article provide a compelling case for the benefits associated with following this approach. By reengineering their supply chain and supporting inventory policies, they will be able to reduce costs while providing a high customer service level.

References


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