Improving Supply Chain Operations Performance
Track: Logistics and Distribution

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Abstract

The intense competitive environment which characterizes many industry sectors is forcing many firms to look for diverse strategies to improve their performance and customer satisfaction. At first, these strategies focused on improving each company's operations, bringing them to higher performance levels. Today this is not enough. It is becoming recognized that to stay competitive, companies need to look for improvement opportunities available due to the integration and excellent management of the supply chain to which they belong. The project described in this paper deals with defining and implementing an improvement program of the supply chain of glass products for a Mexican company located in Monterrey, Mexico.
The purpose of the program is to increase customer satisfaction at lower inventory levels. This on-going program consists of the implementation of several projects including the centralization of end product inventories, improving forecasting precision, promoting alliances with distributors and redefining its commercial product catalog stand out. The report presents a summary of the evolution of the program, a description of the potential benefits and the current status of the efforts.

1. Introduction

Today's competition is so intense that it has driven companies to look for improvement initiatives associated with the integration of the supply chain in which they participate. Improving internal operations is currently not sufficient to maintain the market satisfied while sustaining profitability.

The project described in this paper grew out of the need of a Glassware Mexican company located in Monterrey, Mexico to make significant changes in its competitiveness level in a market eager for better service and response.

This paper deals with the description of an ongoing effort to improve the supply chain performance of a company in terms of consumer satisfaction, inventory levels and rapid response.

The report consists of four core sections. The initial section describes research related to supply chain operations improvement. Here, it is also briefly described the process followed in this project. Then, the analysis and diagnosis of current operations performance for the company is shown. The third section describes the evaluation of the improvement recommendations and related results. Finally, conclusions of the effort and additional suggestions are detailed.

2. Previous Research Literature

Performance improvement has been around since the Industrial Revolution, with initial efforts geared to increase productivity through time measurement and methods improvement techniques. The next great movement for improvement was set by the TQM founders such as Deming, 1982 , Juran, 1989 and others, and those seeking waste elimination such as Taiichi Ohno, and Shingo, 1989 . The emphasis of these improvement efforts have been mainly focused in the shop floor, leaving great improvement opportunities unattended at the supply chain level.

Initial efforts to take these movements to the supply chain level have been given by various researchers. In particular, A.T. Kearney, Inc, developed a series of research studies sponsored by the Council of Logistics Management. The first study surveyed various approaches the U.S. industry was using to measure productivity in physical distribution and ended up with a book (A.T. Kearney,1978). The second study had the following goals: To measure U.S. industry´s progress in improving distribution productivity, to assess the impact environmental factors such as transportation deregulation, oil shortages, recession and others, had on productivity improvement, and to map out paths for further improvement. This effort resulted in a publication (A.T. Kearney, 1983). Finally, the third study conducted in 1991 had an expanded scope that includes not only productivity but the quality dimension also. This effort attempted to understand the changes that have taken place since 1983, anticipate the effect of current issues and trends on logistics management, identify the best and most successful practices in quality and productivity improvement in the logistics process, and articulate the role of the logistics process in successful companies in the 1990´s. This last study is documented in another book, A.T. Kearney, 1991.

Miller, etal., 1991 examine the state of quality in supply chain systems with a survey of 225 international companies and show that only 40% of them had a satisfactory supply chain quality program in place. Along the same line, Sohal, etal., 1999 present a comparison of three studies conducted in North America, Europe and Australia which investigated the adoption of quality management practices in the logistics function. This report compares the results of Miller, etal ,1991, those given by Millen, etal, 1997, and those reported by Terziovski, etal., 1997. Sohal, etal. found that around 75% of the respondents indicated that their firms had implemented a quality program in their logistics function, and out of the 25% who hadn´t, one half were planning to implement it in the next three years.

The Supply Chain Council has developed a model, Supply Chain Operations Reference (SCOR), which contains standard descriptions of management processes, standard metrics to measure process performance, management practices that produce best-in-class performance, and a standard alignment to software features and functionality. This management tool can be used to define strategies for improving the supply chain operations performance.

Beamon, etal, 1998 provide a model to assess, improve, and control the quality of the supply chain process. The framework of the process consists of seven modules; Definition of the process and activities performed, Identification of customers, their requirements, expectations and perceptions, Definition of quality, Determination of current quality measures, Evaluation of current processes and setting quality standards, Improvement of process, and Control and monitoring. This procedure extends the principles of quality management to a supply chain context.

Womack, etal., 1994 and Jones, etal., 1997 extend the concept of waste elimination and lean principles, previously defined by Taiichi Ohno at Toyota, to the whole chain. This

improvement movement focuses on the flow of value creation along the supply chain, looking to eliminate all those activities that do not add value. An optimized supply chain process would be a highly synchronized operation with low inventory levels and very responsive. Hines, etal., 1997 provide a toolkit for mapping the chain and facilitating the identification of waste.

Taylor, 2000 reports the results of a research project carried out in the UK automotive component supply chain. The project was undertaken by the Lean Processing Programme with the purpose of introducing lean supply systems . Its main aim is to eliminate de amplification of demand to improve the supply chain performance. Taylor suggests an approach to identify, measure and eliminate the Bullwhip Effect.

It has been shown that the lack of synchronization, and hence, unfavorable performance level of a supply chain is significantly impacted by the Bullwhip Effect (Simchi, 1999, Lee, etal., 1997). In particular, service , inventory and response levels are related with the degree of intensity of this phenomenon.

Lee, etal. 1997 show that the Effect is originated by the rational behavior of the members of the chain. This implies that firms that want to control and reduce the Effect have to focus in modifying the infrastructure of the chain and the related processes, instead of the behavior of its members. Four factors are identified that contribute to the growth of variability in the supply chain. These are the continuous updating of forecasts, lot ordering, price fluctuation and the use of rationing strategies.

Once the causes of the Bullwhip Effect are identified, their control and elimination are possible. Lee, etal, 1997 recommend the implementation of the following strategies: Information sharing throughout the supply chain, alienation of distribution channels and improving the operating efficiency of the chain.

2.1. Methodology for Supply Chain Improvement

The first step of the project was tutoring a group of executives in several areas of Logistics with the purpose of improving communication and understanding later on. This was then followed by a phase of analysis of the current situation. Information regarding main performance indicators such as service levels, market requirements, inventory levels and order behavior were collected. The structure of the chain and the distribution, production and inventory management system were examined thoroughly. The information was gathered through interviews with personnel across all different levels of the chain (Sales, Demand Planning, Production, and Distribution Departments).

This initial step served as the basis for determining several areas for improvement, which are briefly described in Figure No. 2. The next step was to review previously documented concepts and methodologies that could be used to solve the main problems and evaluate each one´s feasibility in the system under study. Solutions were then elaborated for each problem, and implementation plans were developed.

3. Analysis and Diagnosis

This section describes the assessment of several important performance parameters of the supply chain, and some aspects of its structure and infrastructure considered relevant in their behavior.

3.1 Description of the Supply Chain Structure

The structure of the supply chain consists of three echelons as shown by Figure 1. The first echelon consists of distributors that have direct contact with the customer. Three types of distributors are identified; The retailers formed by department and convenience stores, wholesalers and the international distribution network.

See Figure 1

The Distribution Centers (DC's) of the company are at the next level of the chain. There are four DC's, three of them located at Monterrey, close to the manufacturing plants, and the fourth is located in Xochimilco, central Mexico. This last center is used to distribute products to the southern and central regions of Mexico. It is important to notice that the firm operates with the policy of maintaining inventories for each sku for each market segment.

Finally, two manufacturing plants represent echelon three of the chain. These plants are located in Monterrey, Mexico. The production capacity of both plants total 47 million items per month.

3.2 Inventory and Production Planning and Control System

The company's inventory and production planning and control system can be regarded as a "push system". Every month the demand for each sku in each market segment is forecasted. This is used as the basis for determining the level of production. Once defined that it is necessary to produce, the definitive production program is established considering the size of the economic production runs determined by the company for each sku. Generally, the amount produced is always greater than the one ordered.

It is important to observe that the performance of the system is highly dependant on the precision of the forecasts. Hence, if the precision is deficient the result will be greater inventory levels or greater number of customers unsatisfied. The forecasting process is based on qualitative opinions given by Sales executives. This is strongly influenced by the establishment of sales goals or objectives, which most of the time substitute the results of the forecasting process.

Additionally, it is worth mentioning that the determination of forecasts uses the information of the orders placed by the distributors to the DC's of the company.

3.3 Level of Relevant Indicators

The company produces and distributes a wide variety of glass items for last consumers as well as industrial consumers. These are distributed nationally and internationally through a product catalog. In 1999, this catalog included 448 items.

The company follows the policy of maintaining inventory for all the items in the catalog. A pareto analysis of the sales of these items revealed that 241, which account for 27% of total inventory, were not demanded. These items remained as inventory until they are cleared through promotions.

The critical success factors for competing in the markets where the company participates are price, quality of conformance and response time. All industrial clients as well as the distributors ask the company for improved delivery times and reliability. The trend is for lower lot orders and more frequent shipments. The company's current production facilities consist of process technology and equipment ideal for mass production. They follow policies for producing large economic production runs looking for high utilization rates and increased efficiency. The firm lacks of the flexibility to respond quickly to the market. For this reason, the production strategy has been changed from producing to order to producing to stock.

Customer service levels are also a matter of concern. The firm took a sample of the service levels in terms of fill rate for one of the main distributors of the company (called hereafter as Sor-Ana). They found that Sor-Ana was able to fulfill its needs from inventory on 53% of the time during 1998, increasing it to 71% during 1999 and 2000. However, this is still considered as deficient by both Sor-Ana and the company. Both expect to achieve a fill rate of 95% as a minimum.

Graph No 1 illustrates how the Bullwhip Effect is present along the supply chain of item number 1784587, "molde para pastel". This effect occurs as well with all the items. The coefficients of variation of the demand ordered by Sor-Ana to the company increase about 110% with respect to market demand. This increase in variability unfavorably impacts the forecast precision and the levels of safety stock required to handle it. The average forecast error obtained during the months of June to October of this year was 40% for the retailer segment and 45% for wholesalers.

See Graph 1

3.4 Supply Chain Performance Opportunity Areas

Based on the previous analysis and a discussion with key logistics executives, several areas for improving levels of customer service level and inventory were identified. These are shown in Figure 2 in a cause - effect diagram.

See Figure 2

The most relevant opportunity areas deal with the improvement of the utilization of production capacity and the increase in demand forecasting precision. The use of commercial policies such as promotions and inefficient product catalogs, and production policies based upon economic runs, contribute to very inefficient utilization of productive capacity, and results in the generation of high levels of inventory.

The Bullwhip Effect and its negative impact in forecast precision is caused mainly by the use of promotions, the strategies of lot ordering in distribution and the limited supply chain integration.

The degree of forecast precision decreases with the use of schemes for forecasting and planning inventories for each and every market segment, and the use of subjective forecasting schemes which are biased by the company´s management style.

Once the potential areas for improvement were identified, the team of executives decided to evaluate several of the strategies in a sample of 44 items carried in the catalog, and one of the main distributors.

4. Evaluation of Improvement Strategies

The strategies first selected by the team were ways to simplify the product catalog, improve forecasting precision, and look for a better integration with distributors.

4.1 Re-defining the Product Catalog

The previous analysis yielded that the definition of the catalog is important because it affects the levels of inventory and the adequate use of the production capacity. Several products have very low demand, while others have great acceptance by the customer. Thus, it is important to have a procedure to design a catalog that really represents the needs of the market, and would therefore be a step to reduce diversity and complexity in the chain.

With this in mind, it was decided to use a procedure for designing the catalog based upon a pareto analysis of the sales of the items. In summary, the catalog would only include those items rated as A and B in the pareto analysis. Upon applying this procedure to all the items sold by the company, it was found that the catalog should have been formed of 238 articles instead of 448. The proposed new catalog would result in a decrease of 27% in the cost of inventory, approximately 70,000 USD.

4.2 Improving Forecasting Precision

The use of quantitative forecasting procedures for a sample of 44 items was investigated reaching the conclusions that moving averages and exponential smoothing procedures were the best. The criterion was the minimization of the mean absolute deviations. The more adequate error distributions were normal and lognormal. The estimation of the required safety stock levels was carried out with the expressions given by Brown,1959.

The impact of using these procedures for forecasting the 44 items instead of the qualitative ones yielded a reduction of 216 thousand sku's in safety stock, equivalent to 100,000 USD approximately.

4.3 Centralizing Inventories

The strategy of centralizing inventories for each item originates the possibility of decreasing the level of total inventory due to the reduction in demand variability owed to its aggregation. Since the amount of safety stock is related directly with the variability of demand, one would expect a decrease in this concept after carrying out the centralization.

To verify the application of this concept and evaluate the potential benefits, a comparison of the levels of total safety stock with and without the centralization was carried out. The result was that a reduction of 30% in the level of total safety stock could be achieved. This is equivalent to a reduction of 400,000 USD approximately.

4.4 Establishing Strategic Alliances with Distributors

In order to evaluate the impact of implementing this strategy it was decided to consider one of the main distributors. In this case the store chain Sor-Ana was selected because it had

the infrastructure required to make possible an alliance with the company. The company hasd experienced that when Sor-Ana asked for an item which was not available, the order was cancelled. Hence, a better service level translates directly into more sales. Recall that the current fill rate provided by the company is around 71% and that this should be increased to 95%. Given this desired fill rate goal, it was estimated that the company would have sold to Sor-Ana 25 % more items during the last 20 months ,equivalent to about 230,000 USD.

In addition to the previous benefit, one can also determine the amount of safety stock required when using market demand data instead of orders placed by Sor-Ana. The impact of this strategy was evaluated obtaining an additional reduction in safety stock required of 42%, equivalent to 247,000 USD.

5. Conclusions and Recommendations

Given the favorable results of the evaluation, the firm is currently implementing the following strategies:

- A mechanism to re-design the product catalog.
- New quantitative forecasting procedures.
- The centralization of inventories.
- The establishment of a relation with Sor-Ana to share demand data and inventories.

The team is currently working to extend the strategic alliance strategy with other distributors. Furthermore, the team will eventually have to deal with reducing economic production runs, which was initially avoided because they thought that it was necessary to have positive results to back them up, since substantial investments would probably be required in order to incorporate technology to make productive capacity flexible. Another important obstacle that should be dealt with refers to the management evaluation policies based upon resource efficiency and utilization rates, and unit cost.

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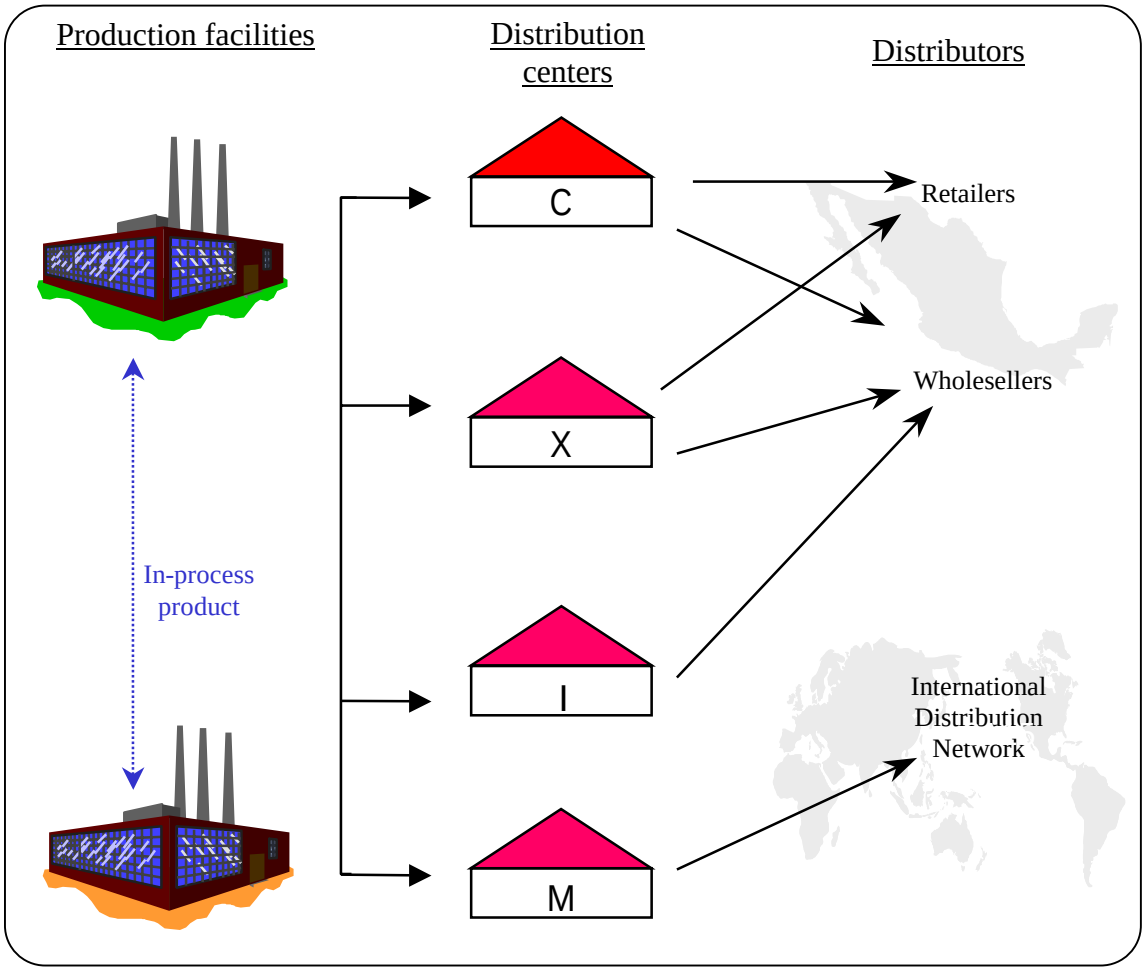
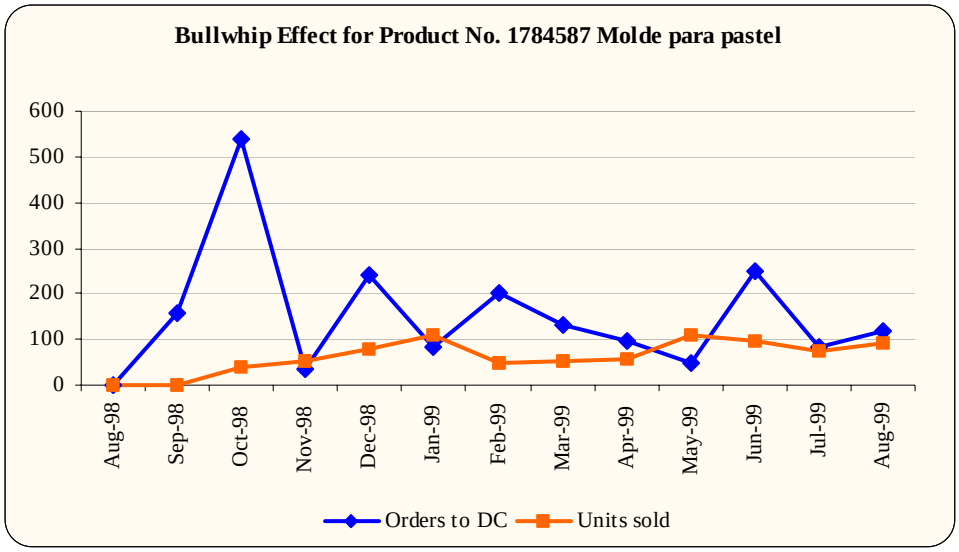


Figure1. Description of Supply Chain Structure



Graph 1. Bullwhip Effect for Item No. 1784587 Molde para Pastel.

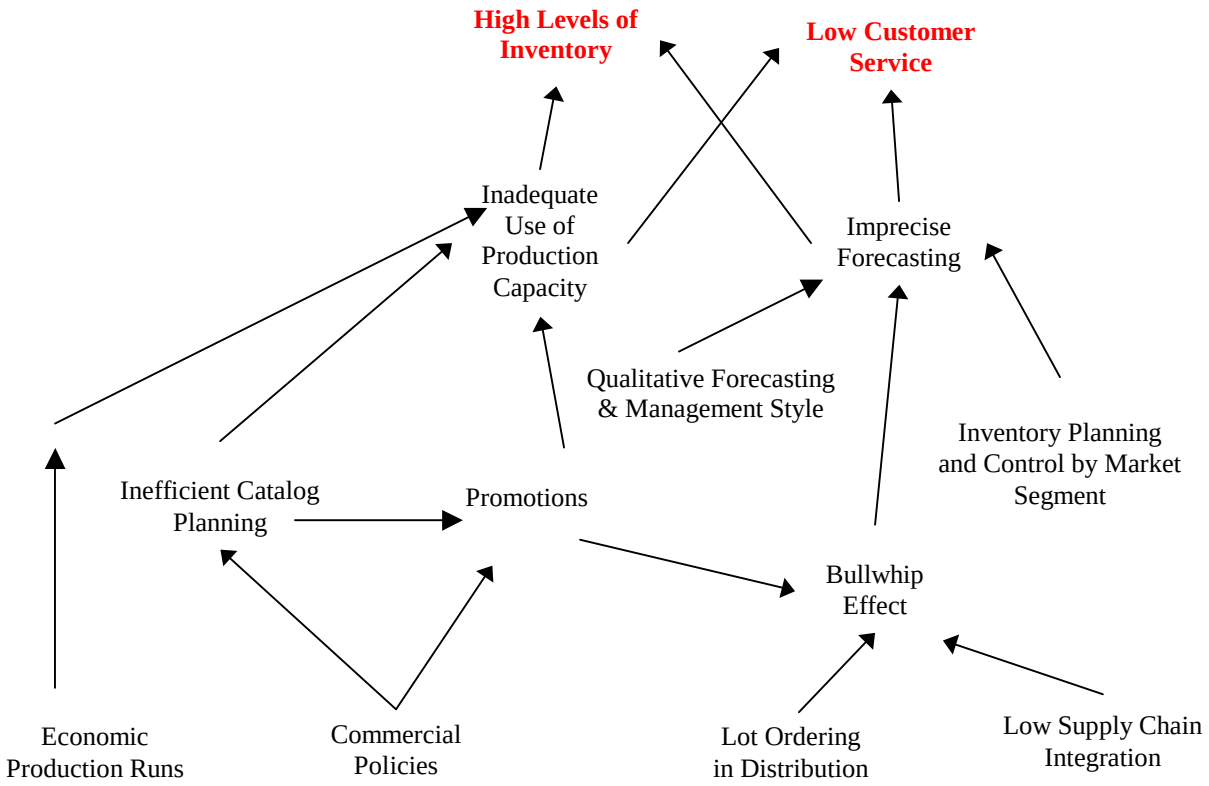


Figure 2. Improvement Opportunity Areas