



SAS® ANALYTICS FOR INVENTORY OPTIMIZATION

Improve Your Supply Chain Investment



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Executive Summary

Since its inception, “inventory optimization” has been residing in the realm of the business innovator or supply chain visionary. Forward-thinking companies have taken these toolsets and shown huge improvements to inventory costs, service levels and customer satisfaction over the old ways of doing business. Achieving savings of 30 to 50 percent in inventory costs, while maintaining or increasing service levels, is not uncommon.

This competitive advantage makes not only for an efficient supply chain, but enables a company to be extremely nimble by giving access to ready cash that would have been tied up in non-liquid inventory assets. Yet, even with ready references from early adopters, inventory optimization stays in a holding pattern. Oddly enough, in a recent Aberdeen Group research study, companies cited inventory optimization as one of the top areas of interest for 2007. In fact, 85 percent of those surveyed were looking into inventory optimization as a supply chain efficiency project.¹

What could be holding back a broad acceptance of inventory optimization when there is so much interest? Over fifteen years ago, Geoffrey Moore stated in his groundbreaking book, *Crossing the Chasm*, that moving from the early adopter to the mainstream meant radically shifting from vision to concrete practicality. Moore’s premise was that a technology will forever stay locked as a fad until it can give the pragmatic executive the understanding of *why* the solution will deliver acceptable results.

As executives understand the logical bridge between the results shown in present-day Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) systems – and the improved numbers provided by using advanced, multi-echelon inventory optimization methodologies – inventory optimization will inevitably become mainstream.

This white paper presents a proof-of-value (POV) process that an organization embarked on with SAS to better understand how SAS® Forecasting and Inventory Optimization improved the results from an already installed ERP system. The effort was to not only show surprising results, but to provide a layman’s path to attaining results and understanding why there was a difference in the results that could be trusted and easily explained.

¹“Global Logistics & Supply Chain Strategies,” *The Aberdeen Group Survey*, April 2007.

Background

A manufacturing organization, on the recommendation of its IT department, adopted an ERP supply chain planning and execution module to manage their maintenance, repair and operations (MRO) inventories. The ERP system produced a strong return on investment (ROI) and was deemed a successful installation by the organization.

Over time however, managers found that the MRO buyers were spending a disproportionate amount of time reviewing inventory levels and making emergency purchases. The result of this behavior was that the MRO staff had grown to accommodate the increased workload, and the cost of rush orders – coupled with high inventory levels – had put a strain on the budget. While the staffing and cost increases were of concern, it was felt that the ERP module was not at fault. It was still producing an acceptable ROI, and service levels were within acceptable ranges.

However, as the organization's business increased, the trickle-down effect on the MRO inventories compounded the now common unacceptable inventory positions. Emergency purchases had become almost a normal business practice. During a fact-finding meeting with SAS, the organization's supply chain management team shared the MRO staffing concerns and cost overruns.

Enhance Versus Replace

As the fact-finding sessions proceeded, it became clear that several issues were very important to the participating executives:

1. The installation of the ERP system and the SCM module had been a huge endeavor from both a cost and time perspective. This investment needed to be justified and, even more importantly, it needed to be protected.
2. The results that had been coming out of the system since it had gone live had provided a good ROI from the previous method of supply chain management. If the results were not as good as they should be, the management team needed to understand why.
3. If a decision was made to purchase an analytical enhancement to the ERP system, the management team needed a POV assessment that would be both compelling and defensible.

The POV Assessment

Interviews with the MRO management team and buyers produced telltale signs of problems with demand signals (forecasting issues) and the resulting supply responses (inventory policies). Due to the misaligned signals, the system was producing incorrect results. The buyers were forced to develop workarounds and/or emergency buy procedures.

The SAS team consulted with the organization's management group and recommended improving the demand and supply signals with a combination of SAS Forecast Server and SAS Inventory Optimization. This combination would reduce the demand and supply variants so that the resulting outputs of the ERP system would be more efficient. The effect of the better outputs would be reduced inventories, fewer emergency purchases and a more productive buying staff.

The organization's management team came up with a set of acceptable hurdles or goals that the SAS solution needed to overcome in order to be deemed successful in enhancing the ERP system. The team defined the acceptable levels of improvement and expressed those improvements not only in monetarily values, but in a reduction in MRO buyer activities.

The Goals of the POV

The goals of the POV engagement need to be measurable and relevant:

1. Reduce capital invested in inventory by a minimum of 15 percent.
2. Maintain a service level of 98 percent while eliminating appropriate inventories.
3. Reduce the time and improve the quality of the management of materials requisitions.

Proof of Value Steps that Lead to Success

A truly comprehensive off-site POV can take one to two months because of the effort needed to ensure all relevant information is examined and validated by everyone involved. There are many “high-speed POVs” promised to organizations as an incentive to take the first step. However, the pragmatic buyer requires more than a cookie-cutter POV. There needs to be a customized view that gives the organization a platform for collaboration. This platform ensures that everyone is comfortable with the process and the results.

POV Roadmap

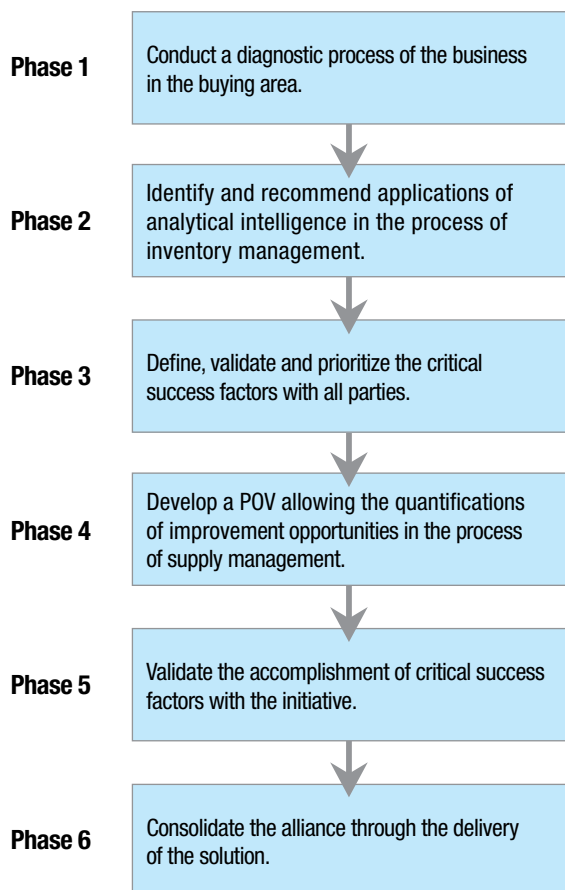


Figure 1. The evolution of activities in the framework of the POV process.

The POV Process

In our example, the collaborative team gathered the relevant data, analyzed it, built the optimization models, validated the results, measured the gains and developed a final presentation that showed both the gains and the business benefits.

The following is a high-level outline of the POV process:

1. Gather the following data to facilitate both demand and supply information for the products:

- 1.1. History of consumption of each part/product in the MRO inventory.
- 1.2. Unit of measure of each part/product.
- 1.3. Hierarchical classification to mimic the organizational system.
- 1.4. Part value or cost.
- 1.5. Desired service levels.
- 1.6. Cost of maintenance.
- 1.7. Cost of ordering.
- 1.8. Other costs such as transportation, etc.
- 1.9. Historical lead-times and actual performance to compute variance.
- 1.10. Current/historical stock policies for each item.

2. Analyze the data (much of this was done as part of the interview process):

- 2.1. Segment the parts into quadrants:
 - 2.1.1. Critical vs. non-critical.
 - 2.1.2. Availability.
 - 2.1.3. Variability of the demand and supply.

3. Build the model:

- 3.1. Create a naïve model for use as the baseline.
- 3.2. Once the model is validated and run, pay particular attention to the “buyer problem” products or parts.
 - 3.2.1. What is creating the outlier affect?
 - 3.2.1.1. Demand variability?
 - 3.2.1.2. Supplier variability?
 - 3.2.1.3. Both?

4. Optimization modeling:

4.1. Demand side.

4.1.1. Align the proper forecasting method to reduce the variance.

4.2. Supply side.

4.2.1. Inventory costs and replenishment costs need to be sharpened.

4.2.1.1. Cost of processing orders.

4.2.1.2. Opportunity cost of capital invested in inventory.

4.2.1.3. Warehousing costs.

4.2.1.4. Handling and counting costs.

4.2.1.5. Other costs such as insurance and taxes.

4.2.2. Additional lead-time information.

4.2.2.1. Take into account the review time costs of the buyers.

5. Validation:

5.1. Beyond the results.

5.1.1. To alleviate the mystery, it is important to show how policy calculations can have a huge effect on how inventories react to demand signals.

5.1.1.1. The ERP module policy structure in action.

5.1.1.2. The SAS policy structure in action.

6. Return calculation:

6.1. Inventory differential snapshot.

6.1.1. Some parts will have adjusted inventories upward with optimization.

6.1.1.1. The buyers were reviewing unnecessarily due to a bad policy.

6.1.2. Some parts will have adjusted inventories downward with optimization.

6.1.2.1. Unnecessary or redundant safety stocks were on hand to achieve the required service level.

6.2. Inventory time series.

6.2.1. The Z-curve correction: with the demand flow in place, the inventories will begin to adjust. Because some inventories are below required levels, an order will result, and this will create an immediate uptick in the inventory levels; however, as the other inventories bleed off, the overall inventory level will decline.

6.2.1.1. The correction timeline: It is critical that the pragmatic buyer understand the time it takes to achieve the optimized inventory level; the projected demand flow will provide the input to show the graphical drop in inventories to the net levels. The return can be shown in an expected time.

7. The final presentation: There is no silver bullet to deliver the perfect final presentation. The key when it comes to solving the inefficient ERP module is to give the organization a transparent view into the results. This means that not only is the information understandable and reliable, but that the organization can participate along the way and can validate any and all points because the organization has made an investment.

A Different Product Perspective

The organization used a basic ABC classification to align products into various critical levels of need to the success of the MRO department's goals. As with most ABC assignments, the A items were deemed to be the most critical to the health of the department and their resulting service agreements to other segments of the organization. Interestingly, the MRO buyers explained that the troublesome products did not adhere to the ABC assignments.

Indeed, there did not seem to be any correlation between the ABC classification and the troublesome products except for one: Because they were classified as A items, they received more review attention, while B and C items were either reviewed on an ad-hoc basis or had their safety stock levels raised.

To get a clear picture of why some items required more review time than others, a different, quantitative approach was needed that went beyond the present ABC system. To delve deeper, the SAS team worked with the organization to classify the products into four quadrants that were graded by:

1. Critical importance to the company (high to low):

- a. Operational continuity: Would the operation stop if this part were out of stock?
- b. Environmental impact: Would the environment be hurt if this part were out of stock?
- c. Human life risk: Would people be adversely affected if this part were out of stock?
- d. Extra risks: Does any operational risk exist that would not be covered by a, b or c?

2. Product availability (based on demand accuracy and replenishment variability):

- a. High demand accuracy and high replenishment speed.
- b. High demand accuracy and low replenishment speed.
- c. Low demand accuracy and high replenishment speed.
- d. Low demand accuracy and low replenishment speed.

This exercise gave the MRO buyers a way to see products from a different perspective than the classic ABC banding methodology. The quadrant was set up as shown in figure 2.

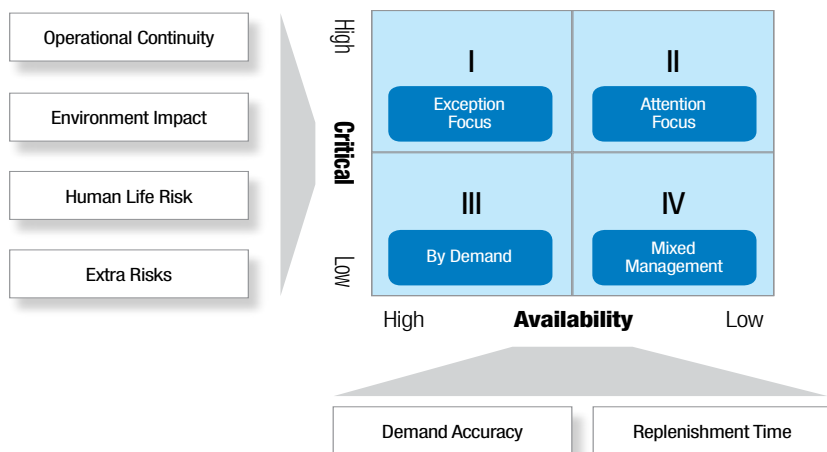


Figure 2. Items segmentation – understanding the customer’s environment.

As the products were placed onto the map, the MRO buyers began to translate the way they treated the products within each of the quadrants. This naming may align with the way your organization treats the data.

Quadrant I: Exception Focused

These items tended to score high on one of the critical risk areas and had a high level of forecast accuracy and a fast replenishment cycle. They were easy acquisition items with minimum levels of inventory. The buyer only had to review the information on an exception basis.

Quadrant II: Attention Focused

These items also had a high score for the critical risk area and had high levels of forecast accuracy. However, because they tended to have a slower replenishment cycle, the products required higher safety stocks to cover the critical nature of the product.

Quadrant III: Demand Focused

These products were low on the organizational risk scale and had a high level of forecast accuracy and a fast replenishment cycle. In this case, the buyer could easily anticipate when and how much to purchase. The safety stock requirements were quite low.

Quadrant IV: Mixed Management

This quadrant was an odd grouping. Since the operational risk was low, forecasting had a high level of variability and the replenishment cycle was slow. As a result, the products tended to be lumped together by an inventory costing factor. This means for low cost materials, the safety inventory is raised and managed automatically while high cost items would be manually reviewed.

An Eye-Opening Moment: Discovery and Insight

As the MRO product portfolio was placed on the quadrants in a hit-or-miss pattern, the organization's executives and buyers uncovered two surprising factors. The first was that there was no correlation between the ABC classification and the placement of the products on the quadrant. Each quadrant had As, Bs and Cs. The second factor allowed the team to uncover why so much time was spent reviewing the data: *86 percent of the products were in quadrants 2 and 4.* (Refer to figure 3 for details.)

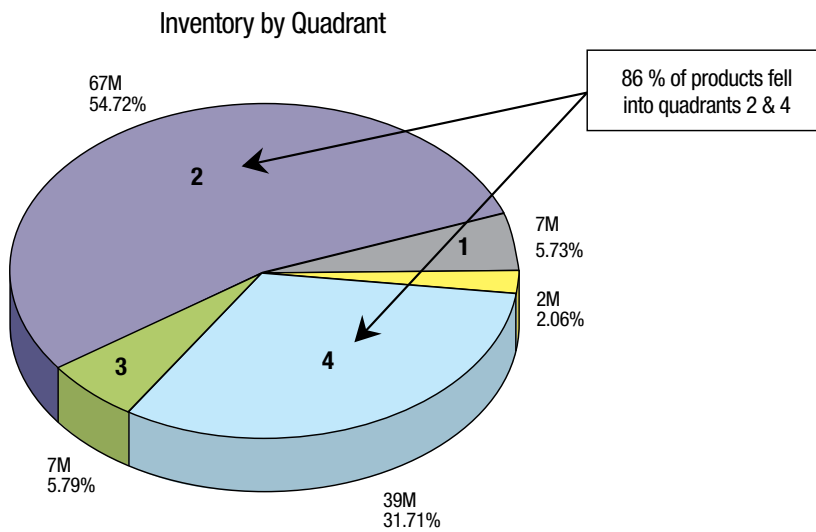


Figure 3. Methodology: descriptive analysis – value of inventory per quadrant.

Why the ERP System Had Trouble with Most MRO Products

Rather than relying on random assumptions to explain why the SAS system could do a better job of providing superior analytics and thus better results, the SAS team set out to show the steps the ERP system took to produce numbers. In turn, once that information was explained, the SAS methodologies could be integrated in helping the ERP system do a better job.

Simulation of the Replenishment Policies

In looking at the forecasted demand versus the actual demand shown in figure 4, one can see the dilemma of the buying staff on the reviewable items. The forecast tends to over- or under-amplify the demand. Over time, this will push the buying staff to raise the inventory policies beyond their already inflated quantities. Since products are banded as like items, a one-size-fits-many method of assigning policies will be used. This is represented by the maximum inventory levels, order points (re-order level) and order-up-to levels.

A telltale sign of a production optimization system is a large gap between reorder levels and the order-up-to level. This type of inventory policy is called “min-max.” In most cases this policy format will require a strong, historical demand pattern to support it adequately from an optimization view point. In fact, the reliance on a strong history will promote a “demand smoothing” that cancels out anomalies. In figure 4 one can see how the forecast on the MRO products did not take into affect four major anomalies.

Service parts and/or MRO products tend to have a highly variable demand pattern and are ordered in small lot sizes that require a quick turnaround time. This means that a different type of forecasting technique that accounts for these variances might be more applicable. Conversely, an inventory policy that adapts to a fast replenishment cycle would allow the system to adapt to the true demand and supply signals. This means that the SAS system, if it was to help reduce inventories and help better manage the ordering process, needs to maximize the response time to a demand signal. This problem in the ERP system was creating the buyer's workaround.

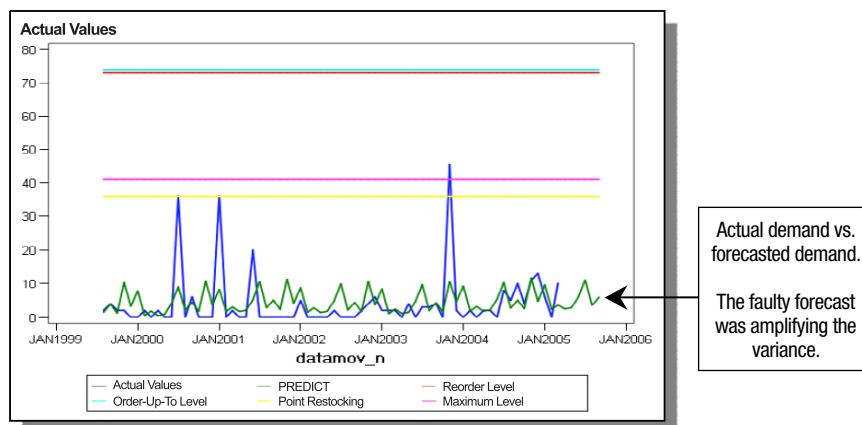


Figure 4. Simulation – replenishment policies.

Simulation of the Present “ERP-SCM Module” Reaction

The SCM Module uses demand input to set the inventory policies. By using min-max and reorder points based on the demand information provided, the system can hold the service level. However, as shown in figure 5, the system is letting the stock fall way below the reorder point because of the length of the replenishment cycle. In three instances, the SCM module let stock fall far below the OOS level. Since there is a large gap between order-up-to and reorder points, the system will promote the inability to adapt to fluctuations.

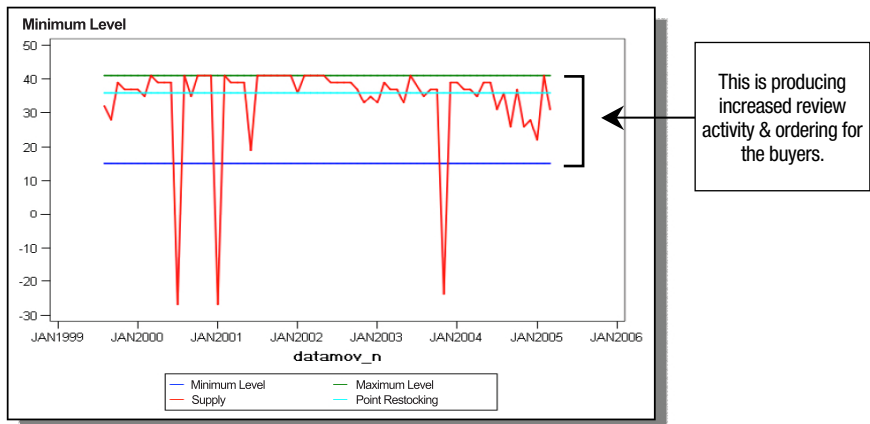


Figure 5. Simulation – ERP service level

Simulation of the SAS® System Reaction

The SAS system used forecasting methods (Croston's and Exponential Smoothing) that help with slow-moving products or products with intermittent demand. Indeed, given the amount of inventory and lot sizes required to support service parts, speed is more important than large amounts of inventory to support the service level needed. Therefore, the inventory and ordering process will be tightened to provide speed and lot size. As viewed in figure 6, by using optimization that is tied to a reorder and order-up-to level, the system can react accordingly.

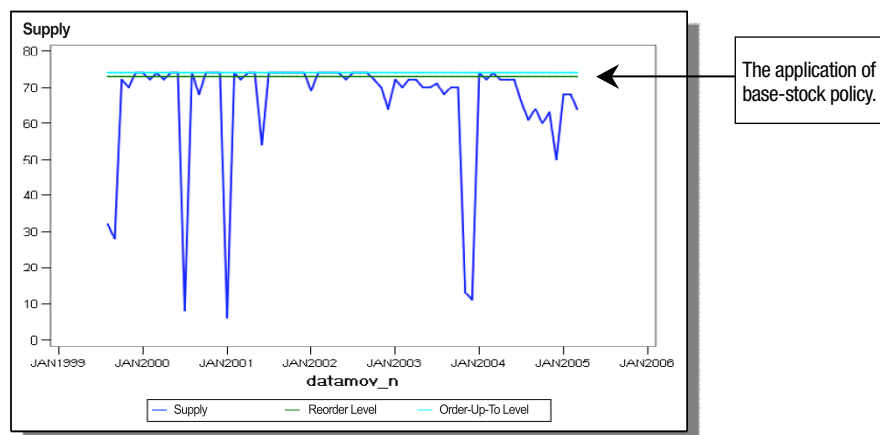


Figure 6. Simulation – service level SAS

The Effect of Policy

Rather than a one-size-fits-all inventory policy parameter, SAS used the business rule format to assign specified base-stock policies when needed. In quadrants 2 and 4, there was a tendency for the products to react better to a base stock format rather than a min-max format. The base-stock format provides a more reliable way to produce a policy on products when the fixed ordering cost is insignificant with slower replenishment.

How Big an Effect Can this Policy Change Have?

Indeed, the products/SKU results in figure 7 show that the affected items were scattered across a range of very slow-moving to regular-moving volumes. However, the items tended to have a corresponding low frequency of demand in relation to the total volume:

- Very slow moving: 18 percent of the affected items.
- Slow moving: 50 percent of the affected items.
- Regular moving: 32 percent of the affected items.

Yearly Demand	Frequency of Demand						Total
	0-2	2-4	4-6	6-8	8-10	10- High	
0-1	Very Slow Moving			18%			7,395 18.01%
1-5							14,463 35.22%
5-10	Slow Moving						4,916 11.97%
10-50	50%			Regular Moving			7,904 19.25%
50-100				32%			2,122 5.17%
100-High							4,268 10.39%
Total	11,695 28.48%	9,364 22.80%	4,656 11.34%	2,920 7.11%	2,050 4.99%	10,383 25.28%	41,068 100%

Figure 7. Methodology – approach

As stated in the previous section, the products in this area react better to a base-stock policy format. By using business rules to identify the product need and applying the appropriate policy format, SAS can better align the needed inventory policy and inventory replenishment requirements.

Consider the earlier findings about the two quadrants that had the most review:

Quadrant II: Attention Focused

These items also had a high score for the critical risk area and high levels of forecast accuracy. However, because they tended to have a slower replenishment cycle, the products required higher safety stocks to cover their critical nature.

Quadrant IV: Mixed Management

Since the operational risk was low, forecasting had a high level of variability, and the replenishment cycle was slow. As a result, the products tended to be lumped together by an inventory costing factor. This means for low-cost materials, the safety inventory was raised and managed automatically, while high-cost items were manually reviewed.

The stochastic or random nature of the demand coupled with the corresponding supply variance produces a problem in a production-based inventory policy SCM module. The optimization methodology is based on systems grounded in production. Production systems require stable and historically strong demand and supply data to produce accurate policies. The resulting production inventory policy would be min-max rather than the more efficient base-stock format. The result of the methodology is that policies would create inventory and ordering structures that would fall outside the service-level thresholds.

In the critical product case of quadrant II, the speed or variance in which the replenishment side could react made the policy one of: a) a rush order – this added cost and buyer review time to the system; or b) raising the policy levels. However, due to the production methods of policies in place, there was already more than needed on hand. Since the organization had put a premium on inventory levels and inventory turns, the rush order became the activity of choice.

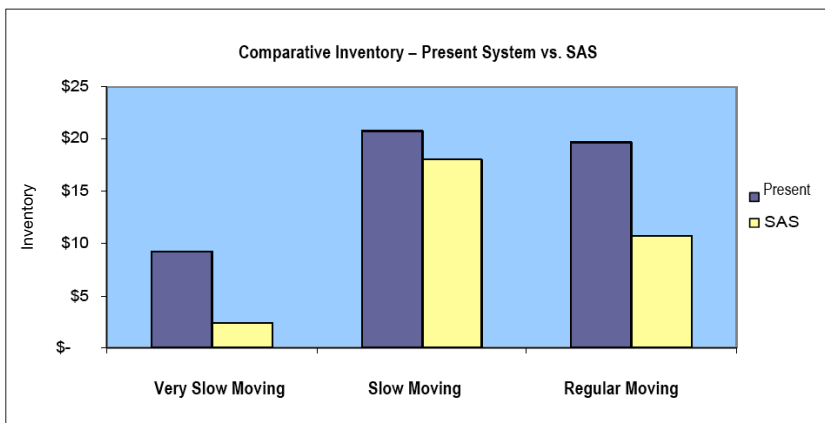
In the mixed management case of quadrant IV, since the demand variability was high and the replenishment cycle short, the buying staff developed a process for handling the products using a cost methodology. This system actually divided the products into the same two areas that were found in quadrant II. If the product was high-cost, it was rush-ordered. If the product was low-cost, the inventory policies were raised.

In a process of adaptation, the organization's buying staff had created a workaround to overcome an inherent flaw in the SCM module. However, in this case the workaround took the incorrect policies and amplified the cost to the inventory levels, the logistics system and the MRO staff workload.

POV Results: SAS® Analytics Enhanced the ERP System

Was There an Inventory Reduction?

The improvement found by using advanced forecasting and inventory optimization methods provided a 37 percent reduction in inventory. By optimizing the network using the SAS system to the required 98 percent service level, *the organization could realize a return of over US\$18.5 million*. This creates a win-win situation, because POV shows that a purchase of the SAS system will provide a ROI, and the money invested in the original SCM can be realized at a quicker pace.



Demand	Present System	SAS	Return	Return
Very Slow	\$ 9,234,100.00	\$ 2,395,021.00	\$ 6,839,079.00	74%
Slow	\$ 20,780,946.00	\$ 17,990,087.00	\$ 2,790,859.00	13%
Regular	\$ 19,682,661.00	\$ 10,777,007.00	\$ 8,905,654.00	45%
Overall Savings	\$ 49,697,707.00	\$ 31,162,115.00	\$ 18,535,592.00	37%

Figure 8. Validation – inventory reduction

How long will it take to achieve the reductions?

Using the projected demand information, the organization can now better understand how fast the excess inventory will be bled off to achieve the ROI. Due to the slow and very slow volume of many of the items, the bleed-off will take over a year. However, half of the change will occur in the first three months. See figure 9 for details.

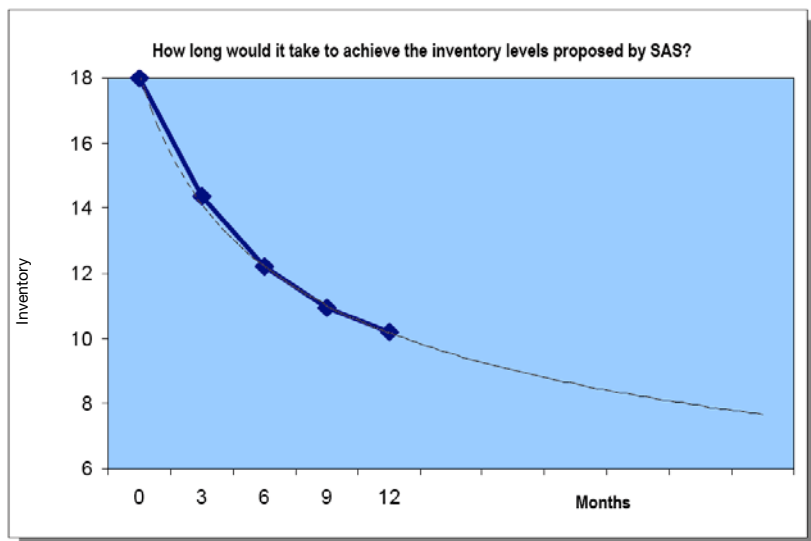


Figure 9. Excess inventory decay

Were There Improved Buyer Efficiencies?

By increasing the trust in the inventory and ordering outputs, the buyers could expect to reduce the amount of time they were using to review and use it for more value-added activities. By applying estimates from the buying staff and management, the organization’s management estimated that the reduced time and improvement in the quality of materials requisitions would allow for the same five resources to process up to 15,000 transactions per month (from the current 8,000).

Measurement of Success of the POV for the SAS System

- Reduction in inventory?
 - Projected goal for success: 15 percent reduction.
 - Realized: 37 percent reduction.
- Maintain a 98 percent service level?
 - 98 percent service level realized while saving \$18.5 million.
 - One-half of the savings will be realized in the first three months.
- Improve buyer efficiency?
 - Dramatic decrease in order review time.
 - Projected to move from 8,000 orders a month to 15,000 orders a month.
 - No increase in headcount.

The ability to reduce inventory in a real-world organization requires more than just an application of algorithms. There are all kinds of factors that come into play, none of which are more important than overcoming the time, money and manpower spent making the present system viable.

By developing a POV that bridged the chasm between proposal and results, SAS enabled the participating organization to understand why the present ERP system was producing the numbers it was and how the SAS system could improve the outputs for best results.

A Fact-Based Decision

Armed with a fact-based POV analysis of the SAS Forecasting and Inventory Optimization system, the organization's management team had the information they needed to show how an investment in SAS Analytics would not only provide a better return on their already installed ERP system, but would help reduce the workload that had developed and been a rule of thumb on their MRO buying staff.

About SAS

SAS is the leader in business intelligence and analytical software and services. Customers at 43,000 sites use SAS software to improve performance through insight from data, resulting in faster, more accurate business decisions; more profitable relationships with customers and suppliers; compliance with governmental regulations; research breakthroughs; and better products and processes. Only SAS offers leading data integration, storage, analytics and business intelligence applications within a comprehensive enterprise intelligence platform. Since 1976, SAS has been giving customers around the world THE POWER TO KNOW®.



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