WHITE PAPER

Looking Beyond Forecast Accuracy to Improve Operations Efficiency

Abstract

As the manufacturing industry increasingly relies on sales and operations planning (S&OP) and integrated business planning (IBP) to achieve competitive advantage, striking a balance between demand and the supply chain is pivotal. This requires integrating business functions including sales, marketing, manufacturing, sourcing, development, and finance into one plan and reducing the cost of resource allocation while increasing operational efficiency and customer experience. However, S&OP meetings are hampered by large gaps between planned and budgeted sales numbers and actual sales figures. At the same time, incorrect forecasting methods and unexpected supply issues result in last-minute changes in production numbers. So, how can manufacturers measure and monitor operational effectiveness of the planning process? This paper takes a deeper look into the various traditional and improved metrics such as demand driven material requirements planning (DDMRP) to help achieve this.

Improving operational efficiency by correlating MAPE and inventory turnover

In a typical scenario, forecast accuracy metrics such as mean absolute percentage error (MAPE) are used to measure the effectiveness of forecasting algorithms or heuristics, and a few lagging indicators such as inventory and customer service levels. However, these metrics fail to measure the effectiveness of production scheduling or internal logistics, which also impact the final output.

To achieve measurable improvements in overall business performance, independently evaluating forecast accuracy and execution effectiveness is crucial to measure their influence on the final inventory and customer service levels. This not only decouples the planning and operational impact on overall performance, but also helps firms understand the limits to improvements through forecast accuracy and lead time reduction.

In fact, research by Gaur et al. has found that high-volume retail services are increasingly analyzing inventory turnover performance and its value.[1] However, the use of correlation statistics between forecast accuracy, as measured using MAPE, and inventory turnover as a metric for operational effectiveness has not yet been explored widely.

Research by Gülşah Hançerlioğulları, Assistant Professor of Istanbul Technical University, has demonstrated in her master's thesis that there is a positive correlation between forecast accuracy and inventory turnover in retail services.[2] She has also validated this nexus by analyzing the top 10 products of a company accounting for nearly 60% of the actual inventory. This analysis has helped retailers understand how a trailing twelve-month inventory turnover had a 78% correlation with forecast accuracy (MAPE with a two-month lag). For example, if the operation-specific forecast accuracy is 80% with an 80% correlation between forecast accuracy and inventory turnover, the fulfillment is expected to be at 64% of inventory turnover (see Figure 1).

Figure 1: Using MAPE to enhance forecast accuracy

[1] Management Science; An Econometric Analysis of Inventory Turnover Performance in Retail Services; February 1, 2005; https://pubsonline.informs.org/doi/abs/10.1287/mnsc.1040.0298

[2] Bilkent University; Sales Forecast Inaccuracy and Inventory Turnover Performance: An Empirical Analysis of the US Retail Sector; July 2010; http://www.thesis.bilkent.edu.tr/0004035.pdf

In addition, Gülşah's analysis is based on a study of 304 publicly listed US companies in the retail industry over a 25-year timeframe (1985-2009). However, she did not have access to the actual forecasts used by these companies and had to resort to the Holt-Winters exponential smoothing algorithm to recreate the forecast accuracy. A drawback of this approach was that these retail companies may have used a different forecast to arrive at the actual inventories, and thus, the inventory turnover. Another issue in the study was that some categories of products, with sporadic or intermittent demand, had unusually low inventory turnover and relatively high forecast accuracies. However, we could certainly arrive at some useful conclusions despite these lacunae.

Deeper research and analysis to support the correlation coefficient between forecast accuracy and inventory turnover can be used as a metric for operational effectiveness in an organization. In an ideal set up, all resource constraints are addressed immediately (that is, infinite capacity) and there are no yield or manufacturing quality issues. This helps accurately translate any forecast into production. Hence, any mismatch between actual demand and the inventory would be a direct result of forecast errors. At the same time, the correlation here would be 100%, and any reduction from this value can be attributed to operational challenges. This is called the inventory swing and bullwhip effect. For instance, let us consider the inventory turnover ratio (TTM) of 4.58 for the chemical industry and 2.01 (according to data from CSI Market, until Q1 2020) for the retail apparel industry. The differential impact of improvement in forecast accuracy can be measured with a 10% increase in forecast accuracy and a 100% correlation between forecast accuracy and inventory turnover. This can reduce the chemical industry's inventory by approximately seven days and the retail industry will witness a reduction of 16.5 days of inventory. This will improve working capital for the retail industry as compared to the chemical industry (see Figure 2).

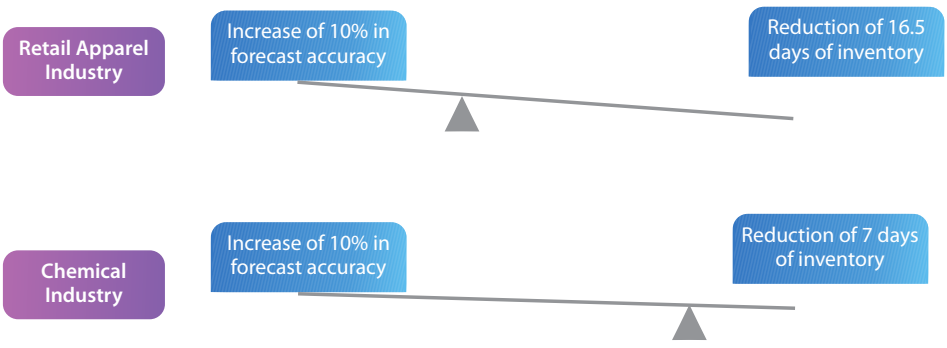

Figure 2: Improving working capital with forecast accuracy

COVID-19 has caused major swings in inventory due to supply chain disruptions and has also changed consumer buying patterns. For instance, there is an unexpected increase in the demand for hand sanitizers and cleaning products resulting in increased demand for the key ingredient, isopropyl alcohol. On the other hand, there is a drastic decrease in demand for certain polymers that are used in automotive coatings. In this case, traditional planning can increase the variability in the supply chain.

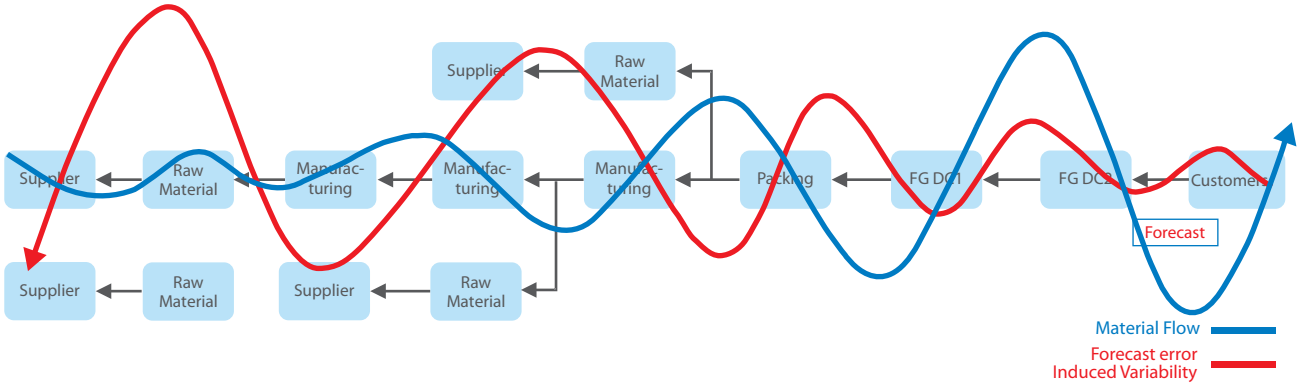

Figure 3: Traditional planning amplifies variability (bullwhip) in the supply chain

Achieving uniformity in supply chain with DDMRP

Leveraging demand driven material requirements planning (DDMRP) with inventory stock buffers can mitigate the bullwhip effect without resorting to costlier—and with questionable results, as explained earlier—methods to improve forecast accuracy. In addition, DDMRP helps strategically place decoupling points within the product structure and supply chain to absorb variability and compress lead times. Also, the buffers aggregate the demand over the lead time, allowing the supply signal to account for recent consumption data, thus reducing the impact of the bullwhip effect (see Figure 4).

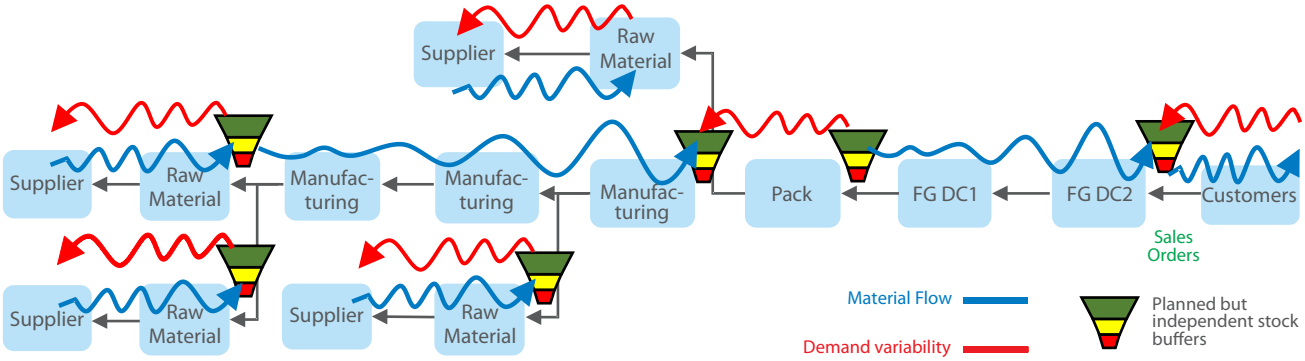

Figure 4: DDMRP reduces the variability in the supply chain

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Using carefully constructed studies, it is possible to understand if a business unit is at the efficiency frontier when further investments in planning fail to yield the desired results. In such cases, correlating forecast accuracy and inventory turnover over a period of two years can predict the trend and identify feasible limits, which is the efficiency frontier. Based on how close a firm is to the frontier, it can choose between improving forecast accuracy, by combining sensory inputs with time series forecasting, and focusing on operational efficiency initiatives through better DDMRP-based safety buffer configurations, replenishment strategies, and so on.

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