Internal Inventory Management: Analysis and Improvement for a CPG Company

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Summary: Company CPG is under pressure to reduce inventory levels of finished goods and raw and pack materials, while achieving its target sales service level. Single-echelon inventory management approach prevents the company from achieving cross stage inventory improvements. We propose a model that pools the variance from the customer facing demand while setting the inventory levels at each stage. Finally, we propose inventory management procedures and guidelines that reduce inventory capital investment, without affecting the service level.

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KEY INSIGHTS

1. Single echelon approach does not provide the overall best inventory levels, because it lacks visibility of the customer facing demand.
2. Items have different demand patterns and business impact, so one-model-fits-all leads to lost profitability opportunities.
3. Visibility to customer facing demand stage is important parameter for setting upstream inventory levels.

Introduction

There is a high degree of variation in Company CPG's supply chain both upstream and downstream. In the customer facing side (downstream), complex demand patterns and seasonality trends in the market drive these variations. International sourcing of raw and pack materials with long lead times, variable supplier's capacity and uncertain responsiveness, add complexity and variation to the upstream stage.

Forecasts are produced for finished goods demand at the end of each year, for the following year, and then they are revised and updated every two weeks. The role of the forecasts is to capture a large portion of the variability that appears in demand and incorporate seasonality trends. Therefore, the accuracy, or otherwise the error of the forecasts, is what determines the level of the safety stocks for the products. The master production schedule has a lot of flexibility, based on the real (Finished Goods) FG' sales, inventories and updated forecasts, and it is adjusted every week, leaving only one week as a frozen period. To buffer against these errors and flexibility, safety stock is kept for Finished Goods and Raw and Pack materials (RPM).

We examine various inventory management strategies both for FG and RPM for a category of Company CPG. The aim is to evaluate if it is possible to lower the overall inventory capital investment without affecting the service level Company CPG promises to its customers. To achieve this, we analyze first the current inventory management policies to benchmark them against the proposed improvements and new policies. The main approach is to include the variance of demand that the further downstream FG stage faces when setting the safety stock for RPM stage. This expands the visibility over both stages instead of locally optimize the safety stocks at each stage. The focus will be on internal company operations and policies.

Methodology

The focus of this project is limited to the inventory strategy within the internal stages of the company. The stages are: 1) FG at the distribution center and 2) RPM at the production warehouse. The relevant data for each SKU was: one-year history of forecast and real sales, their bill of materials, batch order quantity and price.

First, FGs were segmented according to their revenue contribution and demand variability. RPMs were segmented by type and criticality of the material. Raw materials that are common for many FGs were segmented as critical or with high impact.

Then, we built the proposed multi-stage inventory policy model. It determines the adequate levels of safety stocks at each stage. These inventory levels were calculated in order to satisfy the same expected service level for FGs as the current mode. Finally, we evaluated the benefits of the model in terms of value of inventory and final service level provided.

Figure 1 shows the proposed process for setting replenishment policies for finished goods and raw and pack materials. The key input for the FG stock policy is the demand and standard deviation of the FGs. In the proposed model, they can be calculated in two different ways. Then the model selects the most appropriate standard deviation for each FG. The two techniques to calculate the standard deviation are the standard deviation of forecast error SD_{fe} and the variance of demand versus the average demand. The SD_{fe} is calculated as 1.25 times the mean absolute deviation of the forecast (MAD). Then, the model decides which of the two standard deviations lowers the inventory without risking the service of the FG. In general, FGs with high variability will use the demand error, and stable FGs will use the variation over the mean. The output data of the stock policy are: the safety stock (or safety time) as well as the minimum, average and maximum inventory levels for each FG.

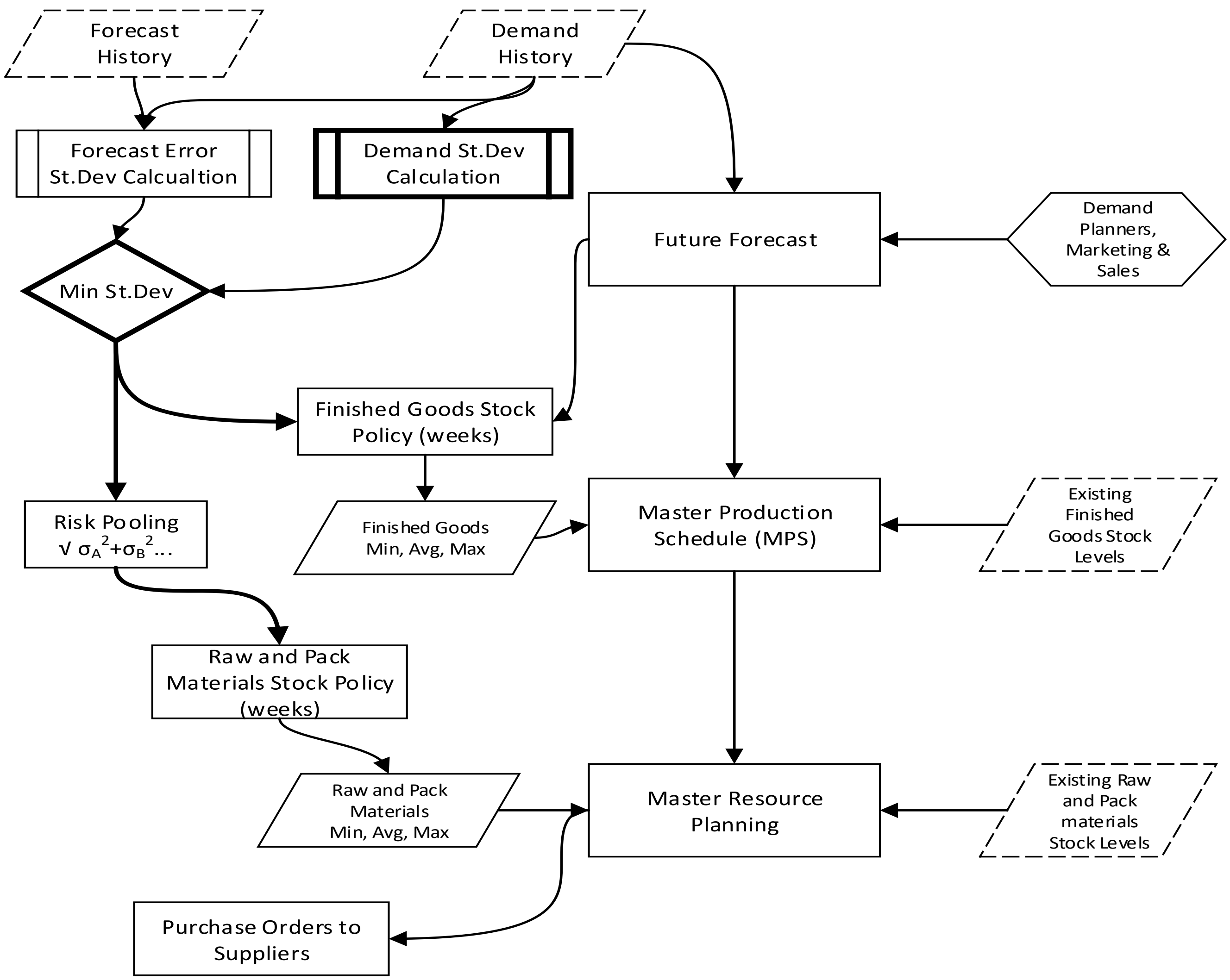

Figure 1. Proposed Process for setting replenishment policies for finished goods and raw & pack materials.

In parallel with building the stock policies, the demand planning team takes the historic demand and the insights of demand planning, marketing, and sales to generate (update) the forecast every two weeks. The forecast is then used again in the stock policy to calculate the safety stocks in terms of future forecasted demand safety time. Each week the master production schedule (MPS) calculates the productions taking as inputs the on-hand inventory, the stock policy and the future forecast.

To compute the RPMs stock policy, instead of calculating the standard deviation from the historic consumption, the model relates to the real variance of demand based on the lagging (according to the lead time of each RPM) forecasts of their finished goods. The proposed model pools the selected FGs variance to each RPM in order to set the corresponding safety stocks. The demand variance of an upstream stage's "RPM-Z" that is consumed by finished goods "FG-A" and "FG-B", is calculated as the pooled variability $\sqrt{VAR_A + VAR_B}$. The calculated standard deviation, the MPS, and the current inventory levels for RPM are considered to develop the material requirements planning (MRP).

Results

The model developed in methodology was tested against the sales data of last twelve weeks of 2017. More than one year's data were used from 82 finished goods corresponding to 373 raw and pack materials in total.

Figure 2 shows the difference between the proposed and the currently used model for a finished good SKU. This SKU has much higher standard deviation of forecast error (SD_{fe}) than its standard deviation of demand (SD_d), because of low forecast accuracy. In this case, the proposed model uses SD_d that results in considerably lower safety stock and reduction on the future inventory levels. Compared to the calculated levels using SD_{fe}, the average inventory is reduced from 5.7 weeks to 1.6 weeks.

For a highly critical raw and pack material which is used in 49 of 83 finished goods (*figure 3*), we compare the resulting inventory levels between using the pooled variance from its dependent finished goods, and the variance of the historical actual consumption.

Overall, the proposed model resulted in reduction of working capital invested in finished goods inventory, from €1.7 to €1.6 million, by maintaining the same cycle service level of 95%. This reduction in inventory is justified from the low forecast accuracy because safety stock is a direct function of either the SD_{fe} or SD_d.

After building the stock policies using the currently used model and the proposed model, we calculated a total inventory reduction of 11%. For finished goods, by adding the decision variable between the SD_{fe} and SD_d to calculate the safety stock resulted in a reduction of 8% in inventory capital investment. For raw and pack materials, by pooling the variance from their dependent finished goods we saw a reduction of 13% in inventory value.

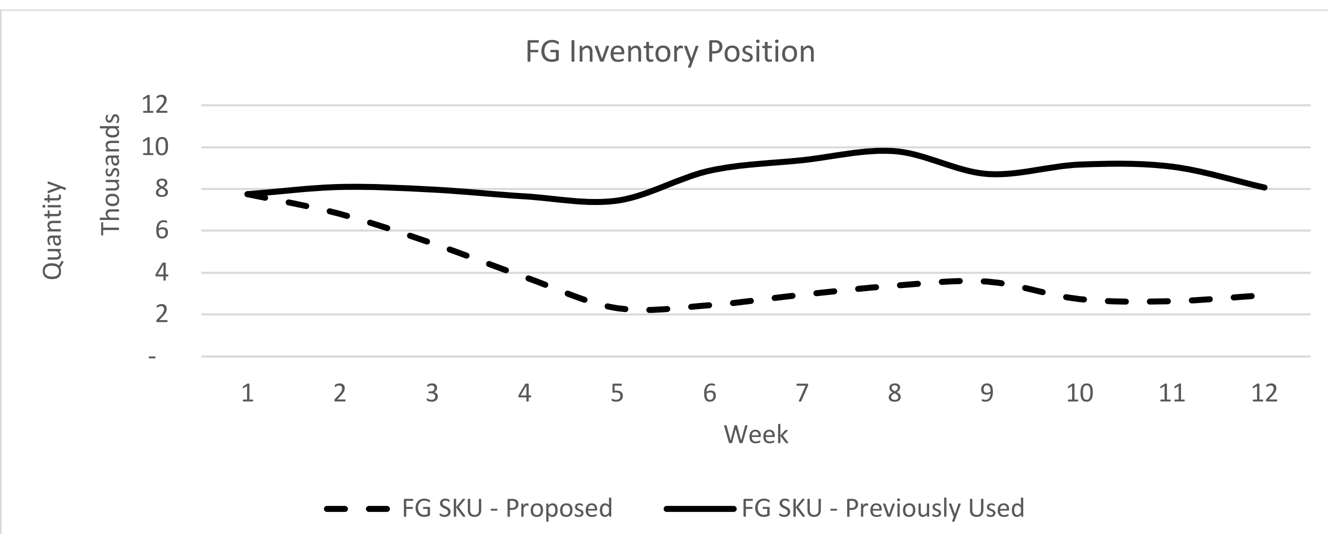

Figure 2. Comparison of inventory position of a finished good, with the proposed and previously used models.

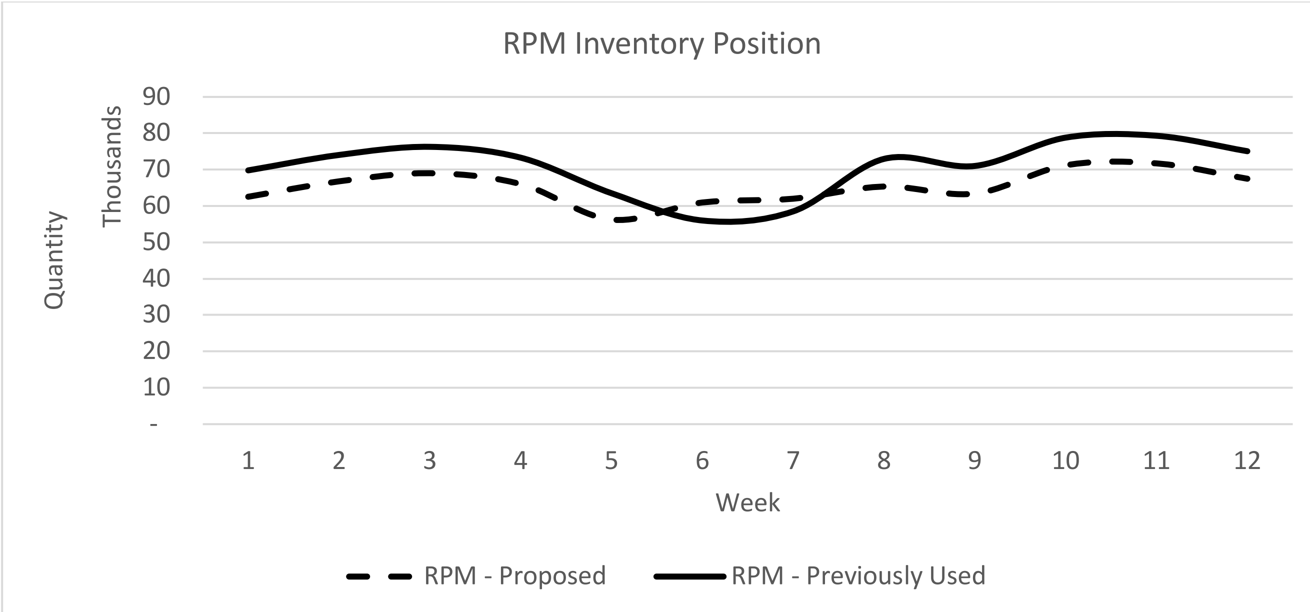

Figure 3. Comparison of inventory position of raw material, with the proposed and previously used models.

Conclusion

This research project started with the question to explore whether "CPG Company" can lower its inventories and simultaneously maintain the same service levels that it promises to its customers. Our research concludes that this is possible when adding a decision variable for finished goods and pooling the variability of FGs to the raw and pack materials' stock policy.

First, for the finished goods inventory keeping stage, we found that by taking into consideration either the customer facing variability of demand, or the variability of the forecasting errors, this results in reduction of weekly average inventory capital that "CPG Company" commits to finished goods whilst maintaining the service level. For each finished good, we selected the minimum between these variabilities. Second, for raw and pack materials, we found that by taking into consideration the variability from their dependent finished goods, instead of the variability of the historic actual consumptions, leads to thirteen percent capital investment reduction to raw and pack materials inventory keeping stage. Connecting the inventory decisions of the multiple stages of any supply chain closer to the customers' demand allows lowering the overall variability of the components.
Third, by improving the forecast accuracy to have lower variance of forecast errors than the variance of demand, will lead to significantly lower inventory capital investments. We recommend further research to develop demand forecasting models that will leverage customer data and will have better predicting power than those currently used. Finally, collaboration with customers for the generation of forecasts is critical to achieve better forecast accuracy.

This project shows how the "Company CPG" can calculate the inventory policies for FGs and RPMs differently, through materials segmentation and visibility of the customer facing demand to its upstream stages. The results confirmed that the current inventory management practices used by the sponsor company are good when the forecast accuracy is good. Also, the proposed model, in combination with the used model, demonstrated that it can give an overall reduction of 11% in inventory capital investment, while maintaining the same service level.

In this project, we focused on the internal (owned by the company) inventories. We recommend further research in building inventory policies at suppliers´, manufacturers´ and customers´ stages based on the actual consumer facing demand.