

SKU Clustering for Supply Chain Planning Efficiency

By Axel Barbará and Tomás Dominguez Molet
Thesis Advisor: Dr. Edgar Blanco

Topic Area: Strategy, Demand Planning, Inventory

Summary: This research proposes an optimized SKU segmentation for global CPG and food brands. This aided inventory managers and supply planners adequately assess the varying needs of diverse products, to cluster them according to comparable needs, to reduce supply chain costs and optimize their supply chain. Utilizing a variety of clustering techniques, we identified a more cost-effective clustering strategy. Additionally, we analysed the comparative costs between our theoretical classification and the actual classification used. Once we identified the disconnect, we calculated the incurred costs for being out of the optimal solution. This included both the effect of safety stock and the stock out costs. Our research created new insights into the comparable cost of under-forecasting and over-forecasting on safety stock and customer service level.



Axel got a BBA degree with focus in general management and economics from UADE and an MBA from IAE Business School, Austral University. His last position before coming to MIT was as Procurement Manager for a financial institution. Afterwards he will be doing an internship with Unilever's Internal Consulting Group before returning to MIT.



Before coming to MIT, Tomás Dominguez Molet graduated in Industrial Engineering from Austral University. He then worked for ExxonMobil and Volkswagen, gathering experience in Product Management & Operation Strategy. Upon graduation, he will be joining Tesla Motors for an internship before returning to Politecnico di Milano for finishing his MBA.

KEY INSIGHTS

1. Misclassifying (underserving) a few high demand items has greater economic impact than overserving a lot of mid-low demand SKU's.
2. Optimal customer service levels (CSL) could be achieved by increasing the highest (i.e., A) category even more than the current 99% and substantially decreasing the lower B and C categories.
3. Optimal CSL's could bring 20% cost reduction in net overage/underage, and a 25% working capital reduction tied to safety stocks.

Introduction

SKU segmentation is a concept that demonstrates an economic benefit behind treating and handling some

products differently than others. Globalized companies are dealing with complex and compelling challenges such as economic volatility, fluctuating commodity prices, supply-chain inefficiencies and increasing customer expectations. These complexities, added to the fact that businesses are having more complex supply chains and have to deal with more SKUs, is changing the way business is done today, demanding that manufacturers find new, smarter ways to meet these challenges. Inventory managers often group inventory items into classes to manage and control them more efficiently. These clusters or segmentations are commonly used for taking decisions in inventory replenishment planning, supply and demand planning, network analysis and ABC classifications.

As companies grow and expand, the products that they handle start getting misclassified as they continue to use old clustering classifications and

methods. As more items are misclassified and planners lack consistency within each other, the following levels of classification will be eventually mistreated by being over served or under served due to this misclassification, wasting resources of the company.

Data and Methodology

The research methodology is divided in four big sets; Data Collection; Qualitative Analysis; Quantitative Analysis; and Cost Analysis.

The development of the overall methodology for this thesis was an iterative process focused initially on the actual methodology for clustering and then the methods for evaluating and presenting alternatives for increased clustering efficiency. Each methodology began with the development and application of a functioning model to evaluate and contrast against the current practices.

1. Data Collection

Exploratory interviews were conducted with supply chain planners and managers for different families of SKUs. Responsible for organizing and updating the data, giving the opportunity to link elements of the data to the specific supply chain process. We also understood the flow of information within the company and how it impacted on the data acquired.

After having understood the company's end-to-end supply chain, we conducted a research with a first data set containing a detailed list of every SKU used by the company in the USA, their characteristics, cost, forecast, snapshots of last year's demand from each RDC (Regional Distribution Center), inventory levels and average shipment quantities. With this information, the qualitative analysis was done.

2. Qualitative Analysis

For a first approach, we focused on analyzing and experimenting with the most representative categories. These categories contained the highest number of SKUs and represented the biggest variability of characteristics as well as representing the biggest demand value per SKU inside each category. After defining the categories and RDCs we validated the numbers and information, by identifying records with missing and incorrect data and creating a clean set of records to perform the ulterior analysis.

The framework on which the methodology bases the final ABC suggested clustering for the company has the following breakdown. The percentage to be considered as a value "A" is to be in the top 20% of that cluster's total Demand, the "B" values, are the items valued between 21% to 95% of the total, and the "C" values are the remaining 5% of the values, to arrive to the 100% values of the cluster.

3. Quantitative Analysis

Using the selected data, we proceeded to compare a classic ABC classification model (80-20) for each RDC by category, contrasting it against the existing company classification, identifying mismatches and outliers that could affect the efficiency of the supply chain.

In order to better capture similarities and differences between the classifications, a matrix like table was made crossing the actual classification and the proposed classification.

Different approaches were modelled for the ABC classification, with the intention of tailoring them to the actual business that will be applied on, maximizing efficiency minimizing supply chain costs. To reinforce the idea, we made a cost analysis in order to understand eventual savings because of mismatched classification.

4. Cost Analysis

To capture the cost we utilized a generic yearly cost function for a firm, selling a product from its inventory, using the following formula:

$$TC = \frac{Q}{2} * \pi_0 * h_1 + \bar{d} * T * \pi_0 * h_2 + A * \frac{\bar{D}}{Q} + C_Q * \frac{\bar{D}}{Q} + I_{SS} * \pi_0 * h_3 + \bar{I}_{SO} * \pi_1 * \xi * \frac{\bar{D}}{Q}.$$

The focus of the analysis was the incidence that the mismatching between the classifications had specifically in the fifth and sixth terms of the Total Cost formula. This terms are associated with the costs of uncertainty.

$$Safety Stock Cost = I_{SS} * \pi_0 * h_3 \text{ and } Stock Out Cost = \bar{I}_{SO} * \pi_1 * \xi * \frac{\bar{D}}{Q}.$$

After this, we decided to compare the costs with their real classification and Customer Service Levels (CSL) (AA – 99,5%; A-99%; B-98%; C-97%) against a more standard service level allocation

Results

We found that their classification was biased towards the A and AA categories, comprising this two almost half of the total amount of SKU's (figure 1).

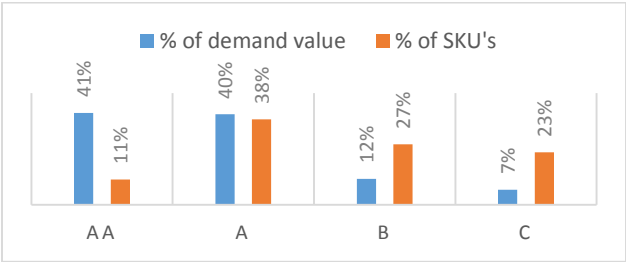


Figure 1: Existing Clustering Methodology percentages

Through segmenting each category and ranking every SKU from biggest to lowest demand, we plotted them to see graphically how the segmentation was done. We did the same process but reclassifying the SKU's first according to an 80-20 classification. Both plots are observed here (Figure 2 and 3):

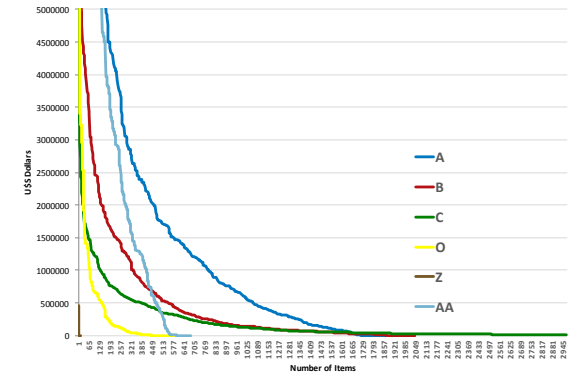


Figure 2: Current ABC Classification Chart

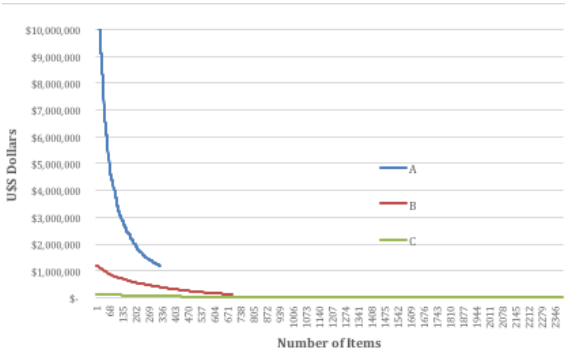


Figure 3: Theoretical Optimal ABC Classification Chart

We then tried to match their classification through following the process that we learned about through our interviews and communications with the company, but this prove to be quite challenging. Even adjusting for many possible factors, we could never get a match of over 75% between our classification and theirs.

This showed that even though they have a well defined process, at some point the supposed classification is overwritten, possibly by the category planners, and this generates the mismatches. After observing these disparities, we calculated the cost of the mismatches. We estimated that the company is bearing extra costs for the disparities. The highest extra cost comes from missing SKU's that should be A's instead of B's or C's.

We continued with proposing an optimized classification, and realized that even further savings could be achieved, of up to a 20% reduction in the total cost of safety stock and shortage. Furthermore, this optimized service levels could achieve a 25% reduction in working capital tied to keeping the safety stock levels.

Conclusions

The research showed that the company has a big opportunity to improve their current SKU classification. There is an opportunity to change their customer service levels to optimize their expenditure and reduce their working capital requirements. There is also an opportunity to adjust their current methods to meet their classification standards better.

We saw that even though the company has ~50% of their SKU's as A/AA, their loss in misclassification still comes from SKU's that should be A's but are B's or C's. This potential lost sales overcomes the savings. An interesting insight of the research is that the optimized values change their proposed service levels in different directions according to the category. We realized that in order to achieve net savings, we had to increase the service level for the A products, which was initially very high. This is due to the fact that the loss sales overcome the increased inventory cost in this high demand items. However, with the B and C categories, the company can lower the service level by two digit deductions and still have the inventory savings overcome the lost sales loss.

The company has the opportunity to reduce their inventory cost expenditures and their working capital requirements by improving their classification process and optimizing their service levels.