SKU Stratification Methods in the Consumer Products Industry

By: Jiaxin Jiang and Andrew Steverson
Thesis Advisor: Eva Ponce

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Summary: To identify more comprehensive stratification methods to manage inventory more efficiently, this thesis explores SKU stratification methods that consider multiple SKU characteristics. We applied four methods (Single Factor, Dual-Matrix, Analytical Hierarchy Process, and Clustering) to the data of our sponsor, a Consumer Packaged Goods company. Our research indicates that the Analytical Hierarchy Process is the most viable and comprehensive method for stratifying SKUs. It allows for a flexible number of stratification factors, different importance levels of the factors, and user control of the number of classes and class sizes.

Before coming to MIT, Jiaxin Jiang worked as IE planner at Micron Technologies for three years and as demand planner at Hewlett Packard for two years. Upon graduation, Jiaxin will join Apple Singapore as a planner in Supply Demand Management.

Before coming to MIT, Andrew Steverson volunteered for a year with the World Race. Prior to that, he worked for three years in the Integrated Planning Group at Georgia-Pacific. He holds Bachelor's degrees in Spanish from Arizona State University and Aerospace Engineering from Auburn University.

KEY INSIGHTS

1. SKU stratifications based on single factor and multiple factors yield significantly different results. It is insufficient to stratify SKUs based on the single factor of dollar volume.
2. Analytical Hierarchy Process is the most viable and comprehensive method for SKU stratification. It allows a flexible number of factors and user input on the importance level of factors.
3. The machine learning technique, clustering, does not allow the users to decide the class sizes. It is thus impractical for use in SKU stratification.

Introduction

Stock Keeping Unit (SKU) stratification is a widely-employed inventory management method. The idea is that a small subset of products is more important to the company than the rest of the products. SKUs are ranked by importance from high to low and classified into group A, B, C, etc. This approach focuses management attention on the important products. It also reduces the number of items to be managed from hundreds, or even thousands, to a handful (usually 3-5).

Traditionally, it is common practice to stratify SKUs based on the single factor of dollar usage (annual demand times average unit price). The problem is that it over-emphasizes the importance of SKUs with high dollar usage and de-emphasizes SKUs with low dollar usage. Apart from dollar usage, other important factors should be considered in inventory stratification.

The sponsor company for this thesis is a leader in the Consumer Packaged Goods (CPG) industry. Their current inventory stratification method is single factor analysis based on sales volume. The motivation of this project is to identify more comprehensive stratification methods to manage their inventory more efficiently.

Stratification Methods

We first identified three relevant stratification factors for our sponsor company: velocity, volatility, and profit margin. Velocity represents sales volume. Volatility captures demand fluctuation. Profit margin considers the financial implications to the bottom line. With these three factors, we applied and evaluated four stratification methods: Single Factor, Dual-Matrix, Analytical Hierarchy Process (AHP), and Clustering.

1. Single Factor Analysis

For each relevant factor, we performed a single factor analysis. We calculated the values of the factor for each SKU, and ranked the SKUs by value. We then charted the ranked values to identify the natural breaks in the data. These natural breaks helped us to identify the stratifications. To ensure consistency between methods, we also identified stratifications based on percentages of SKUs.

2. Dual-Matrix Analysis

The dual-matrix method takes into account two factors at a time. We first applied single factor analysis for each of the two factors. Each SKU was given a classification by a single factor 1, and then another classification by a single factor 2. The two stratifications were then cross tabulated (as shown in Table 1) to produce a final stratification.

Factor 2 \ Factor 1	A	B	C	D
A	A	A	B	C
B	A	B	C	D
C	B	C	D	E
D	C	D	E	E

Table 1. Dual Matrix Key

For example, say product X has been identified as a B product for factor 1 and C for factor 2. This means that product X corresponds to the second column (labeled ‘B’ at the top) and the third row (labeled ‘C’ to the left). The intersection of the second column and the third row is labeled ‘C’. In this analysis, product X would be classified as a C product.

3. AHP

In AHP, criteria are arranged into a hierarchy of one or more levels. In this case, since we only had three factors, they were placed on a single level.

We asked our sponsor company to do a pairwise comparison on the importance of the three factors. We then transformed the pairwise comparison into weights using eigenvectors. We normalized the values of the three factors between 0 and 1. Then we computed a weighted composite for each SKU. In other words, the normalized value for each factor was multiplied by the corresponding weight. The results then were summed for each SKU.

The SKUs were ranked in terms of the composite value from highest to lowest. With this ranking, strata were identified based on the desired percentages of SKUs.

4. Clustering

Clustering is a machine-learning technique performed by specialized software. For this project, we used the K-Means clustering tool in the software JMP Pro. Our relevant factors and the desired number of clusters were input into the clustering tool. The output generated is SKUs groups into stratifications.

Results

We generated stratifications using each of the above four methods and compared the results.

From clustering, the number of SKUs in a cluster is determined entirely by the algorithms. The resulting class sizes in this case ranged from 3 SKUs to 283 SKUs. Since we have no control over class size, it is impractical to apply clustering in actual SKU stratification.

As we observe in Figure 1, the results from the single factor method and the AHP method are very different. SKUs from each classification as determined by single factor analysis are identified in every other classification when submitted to AHP. These differences indicate that the additional factors included in AHP cause significant changes in classification. This fact confirms the importance of considering more than one important factor in SKU

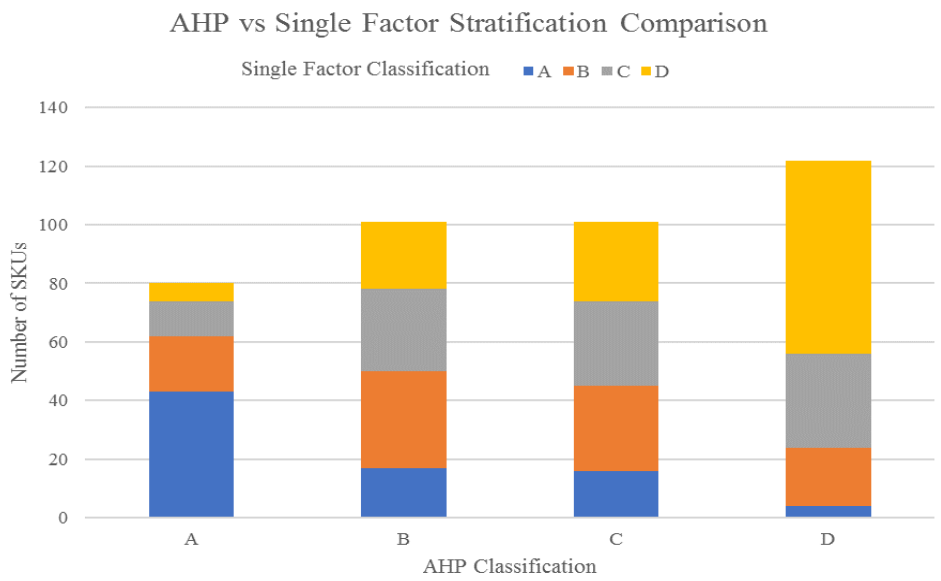

Figure 1. AHP vs Single Factor (Velocity) Stratification Comparison. Comparison of the results from single factor (velocity) and AHP analyses. Each color represents one class from single factor analysis; each stacked bar is one class from AHP analysis.

stratification. Once more, this confirms that the use of a single factor is insufficient for SKU stratification.

Each of the four methods analyzed in our project has its own strengths and weaknesses. Table 2 presents a comparison of the methods in five key areas. These areas were selected based on the practical considerations a practitioner would have when implementing a SKU stratification method.

Our final recommendation to the sponsor company is the AHP method. First, AHP is a comprehensive method. With the ability to include an infinite number of factors, none of the other methods were more comprehensive. Second, AHP allows subjective input on the relative importance between factors. This is critical because it enables the customization of the stratification based on different purposes of analyses. For example, analyses that focus on cost savings will have different emphases than analyses that focus on customer service. Finally, AHP has the flexibility to become both single factor and dual matrix analyses by adjusting weightage of factors accordingly. In other words, AHP is an all-encompassing model, more flexible and powerful than the other models.

Applications

SKU stratification can be readily applied to inventory value management. With the stratification result, we calculated the total inventory value in each class. We took a snapshot of the inventory quantity by SKU. Then we multiplied the inventory quantity by product cost for each SKU. The resulting inventory value was then grouped by the AHP SKU stratification. Starting from SKU stratification, our sponsor company will be able to set an inventory value target for each class. They can then monitor actual inventory value by class to ensure optimal working capital management. Our SKU stratification method will build a solid basis for inventory value allocation.

Another application of SKU stratification is service level generation. Using Economic Order Quantity analysis, we calculated the desired service level for each SKU. We then identified the maximum,

Method	Factors Considered	Comprehensiveness	Ease of Implementation	Ability to Customize Class Size	Software Required
Single Factor	1	Low	High	High	-
Dual Matrix	2	Medium	Medium	Medium	-
AHP	3 or more	High	Medium Low	High	Eigen Vector Calculator
Clustering	3 or more	High	Medium	Low	JMP

Table 2. Method Comparison

minimum, and average service level for each class. These values will allow management decisions to be made about service level at an aggregate level of the stratifications.

Conclusion

Our analysis indicates that different SKU stratification methods give very different results. We found that the Analytical Hierarchy Process is the most viable and comprehensive method. It allows for a flexible number of stratification factors, different importance levels of the factors, and user control of class sizes.

Several related questions remain uninvestigated in this research. One important research topic will be the identification of strata cut-offs and class sizes. Another area of interest is the appropriate re-generation frequency of SKU stratification. Finally, new products and exception handling can be further researched.

Our research indicates that it is rewarding for companies to employ multi-criteria stratification methods to manage inventory more comprehensively, and AHP is the method that we recommend for such an application.