Outline

- Motivation
- Objectives
- Methodology & Results
- Recommendation
- Application
- Potential Next Steps
“There has to be a better way”

- Historically, SKU Stratification was based on sales volume
- Sponsor company asked for more comprehensive analysis methods
- Tool to be applied to variety of relationships between manufacturer/distributor and retail customers
Objectives

To identify a better SKU stratification method for Consumer Packaged Goods companies to better serve their retailers.

To provide a ready-to-use stratification modelling package for our sponsor company.
Relevant Factors

- **Sales Volume** - still a key consideration
- **Volatility** - critical in forecasting and replenishment
- **Profit Margin** - impact to the bottom line
Data

Sales volume data by SKU by DC for the past two years

Current price & cost by SKU for retailer
Methods Under Consideration

- Single Factor
- Dual Matrix
- Analytical Hierarchy Process (AHP)
- Clustering
Single Factor

- Rank SKUs based on one criterion - current method
Dual Matrix

- Two sets of single factor classifications
- Cross-tabulation to determine new classification
Analytical Hierarchy Process

- Pairwise comparison of importance of factors => weightage

<table>
<thead>
<tr>
<th>Factor</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Volume</td>
<td>0.43</td>
</tr>
<tr>
<td>Profit Margin</td>
<td>0.43</td>
</tr>
<tr>
<td>Volatility</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Values are normalized to allow for direct comparison

Weighted sum calculated and ranked

Ranked sum => stratification
Analytical Hierarchy Process

AHP vs Single Factor Stratification Comparison

AHP Classification

Single Factor Classification

Number of SKUs

A
B
C
D

A
B
C
D

Analytical Hierarchy Process
Clustering

- Algorithms group data points based on mathematical proximity
- K-means clustering for SKU stratification
- Data supplied to specialized software - JMP Pro 12
Clustering

- Size of each cluster is variable & cannot be controlled
- Impractical to apply to inventory management

<table>
<thead>
<tr>
<th>Cluster #</th>
<th>3 Clusters</th>
<th>4 Clusters</th>
<th>5 Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>275</td>
<td>277</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>118</td>
<td>3</td>
<td>283</td>
</tr>
<tr>
<td>4</td>
<td>113</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>
## Methods Comparison

<table>
<thead>
<tr>
<th>Method</th>
<th>Factors Considered</th>
<th>Comprehensive Level</th>
<th>Ease of Implementation</th>
<th>Ability to Customize Class Size</th>
<th>Software Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Factor</td>
<td>1</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>-</td>
</tr>
<tr>
<td>Dual Matrix</td>
<td>2</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>-</td>
</tr>
<tr>
<td>AHP</td>
<td>3 or more</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Eigen Vector Calculator</td>
</tr>
<tr>
<td>Clustering</td>
<td>3 or more</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>JMP</td>
</tr>
</tbody>
</table>
Recommendation

- We recommend the AHP method for SKU stratification
  - Comprehensive
  - Flexible
  - User determination of importance of different factors
### Before and After

<table>
<thead>
<tr>
<th>Product</th>
<th>Sales Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKU 1</td>
<td>D</td>
</tr>
<tr>
<td>SKU 2</td>
<td>A</td>
</tr>
</tbody>
</table>

Significant change in classification from Single Factor to AHP
Applications

A better way to focus on and invest in the important products

Forecasting

- More complex models for ‘A’ SKU
Service Level

- Calculated per SKU, then aggregated for the classifications

\[ Q^* = \sqrt{\frac{2c_tD}{c_e}} \]

\[ P[\text{StockOut}] = P[x \geq k] = \frac{Qc_e}{Dc_s} \]

Service Level = 1 - P[StockOut]

- \( c_t \): Ordering Costs ($/order)
- \( c_e \): Excess holding Costs ($/unit/time)
- \( c_s \): Shortage costs ($/unit)
- \( D \): Demand (units/time)

<table>
<thead>
<tr>
<th>Service Level</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>69%</td>
<td>100%</td>
<td>95%</td>
</tr>
<tr>
<td>B</td>
<td>70%</td>
<td>97%</td>
<td>91%</td>
</tr>
<tr>
<td>C</td>
<td>28%</td>
<td>95%</td>
<td>84%</td>
</tr>
<tr>
<td>D</td>
<td>12%</td>
<td>90%</td>
<td>72%</td>
</tr>
</tbody>
</table>
Potential Drawbacks

- User input via pairwise comparison
- Misunderstanding of relationship of inputs to results
Potential Next Steps

- Exception handling
  - New products
  - Promotions
- Set inventory management strategies for stratification
  - How do customers measure company service?
Thank you
Q & A