Vivian Ellis Factor Analysis

The HBAT 200 database will be used to preform factor analysis and determine which of the 13 performance variables could be reduced and grouped. This database is like HBAT however, there is 200 records instead of 100. Firstly, the correlation matrix shows that ecommerce is significantly correlated to complaint, advertising, sales image, ordering, price flex, and delivery speed with a Pearson’s correlation coefficient of 0.19176, 0.50520, 0.78822, 0.21689, 0.18624, and 0.24081 respectively. Production quality is significantly correlated to product line, pricing, and price flex with a p-value <.01 and a Pearson’s correlation coefficient of 0.50930, -0.44811, and -0.48721 respectively. Tech support and warranty are highly positively correlated at 0.83782 with ap-value <.01, this would lead me to believe that HBAT provides excellent tech support for those customers with warranties. In addition, since complain and advertising are significantly correlated to each other and ecommerce, they share the same significantly correlated variables as ecommerce; sales image, ordering, price flex, and delivery speed.

Figure 1 represents the Measure of Sampling Adequacy, we will identify values < .5 to be bad and delete the single least value. Product line and price flex both have an MSA <.5 however, price flex has the least value at 0.41928952. Price flex will be deleted, and factor analysis will be rerun to get the new MSA values.

Figure 1: Measure of Sampling Adequacy

| **Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.63247661** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Prod\_Qual200** | **Ecommerce200** | **Tech\_support200** | **Complaint200** | **Adv200** | **Prod\_Line200** |
| 0.89027960 | 0.68562130 | 0.51681179 | 0.93856054 | 0.76758408 | 0.46467719 |

| **Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.63247661** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Sales\_Image200** | **Pricing200** | **Warranty200** | **New\_Prod200** | **Ordering200** | **Price\_Flex200** | **Del\_Speed200** |
| 0.63123061 | 0.91236725 | 0.53842475 | 0.57098786 | 0.92905433 | 0.41928952 | 0.55835110 |

Rerunning factor analysis without price flex gives a higher overall MSA at .69153034. Figure 2 represents the new Measure of Sampling Adequacy. All MSA values are above .5.

Figure 2: New Measure of Sampling Adequacy

| **Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.69153034** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Prod\_Qual200** | **Ecommerce200** | **Tech\_support200** | **Complaint200** | **Adv200** | **Prod\_Line200** |
| 0.62788549 | 0.67869567 | 0.51437953 | 0.79592458 | 0.77749981 | 0.70410518 |

| **Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.69153034** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Sales\_Image200** | **Pricing200** | **Warranty200** | **New\_Prod200** | **Ordering200** | **Del\_Speed200** |
| 0.65498753 | 0.68239999 | 0.53309596 | 0.56080584 | 0.85514114 | 0.71073277 |

The eigenvalue criterion extracts the number of factors in which the eigenvalues are > 1 where we will extract 4 values, as see in the table below.

| **Eigenvalues of the Correlation Matrix: Total = 12 Average = 1** | | | | |
| --- | --- | --- | --- | --- |
|  | **Eigenvalue** | **Difference** | **Proportion** | **Cumulative** |
| **1** | 3.70469974 | 1.37656394 | 0.3087 | 0.3087 |
| **2** | 2.32813581 | 0.64324878 | 0.1940 | 0.5027 |
| **3** | 1.68488703 | 0.41421562 | 0.1404 | 0.6431 |
| **4** | 1.27067141 | 0.31847694 | 0.1059 | 0.7490 |
| **5** | 0.95219446 | 0.37911244 | 0.0793 | 0.8284 |
| **6** | 0.57308202 | 0.08521256 | 0.0478 | 0.8761 |
| **7** | 0.48786946 | 0.13336289 | 0.0407 | 0.9168 |
| **8** | 0.35450656 | 0.13242417 | 0.0295 | 0.9463 |
| **9** | 0.22208239 | 0.03475414 | 0.0185 | 0.9648 |
| **10** | 0.18732825 | 0.05226794 | 0.0156 | 0.9805 |
| **11** | 0.13506031 | 0.03557775 | 0.0113 | 0.9917 |
| **12** | 0.09948256 |  | 0.0083 | 1.0000 |

The bolded values indicate high loadings.

| **Rotated Factor Pattern** | | | | |
| --- | --- | --- | --- | --- |
|  | **Factor1** | **Factor2** | **Factor3** | **Factor4** |
| **Prod\_Qual200** | -0.02793 | -0.01662 | **0.83653** | 0.08606 |
| **Ecommerce200** | 0.08018 | **0.88303** | -0.03925 | 0.04649 |
| **Tech\_support200** | 0.07059 | 0.01061 | 0.01624 | **0.95408** |
| **Complaint200** | **0.92099** | 0.11907 | 0.10112 | 0.07778 |
| **Adv200** | 0.16928 | **0.78396** | 0.01731 | -0.04025 |
| **Prod\_Line200** | 0.55194 | 0.03698 | **0.67765** | 0.14734 |
| **Sales\_Image200** | 0.15635 | **0.90772** | -0.10995 | 0.08884 |
| **Pricing200** | 0.00176 | 0.17188 | **-0.79413** | -0.08087 |
| **Warranty200** | 0.12415 | 0.06977 | 0.05248 | **0.94234** |
| **New\_Prod200** | 0.13261 | 0.02722 | 0.30581 | -0.10774 |
| **Ordering200** | **0.86106** | 0.15131 | 0.06554 | 0.07500 |
| **Del\_Speed200** | **0.93121** | 0.19243 | 0.11231 | 0.05700 |

Where all factors load on a variable,

Factor 1: complaint, ordering, and delivery speed

Factor 2: ecommerce, advertising, and sales image

Factor 3: product quality, product line, and pricing

Factor 4: tech support and warranty

However, not all variable communalities are above .5 (see new product below).

| **Final Communality Estimates: Total = 8.988394** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Prod\_Qual200** | **Ecommerce200** | **Tech\_support200** | **Complaint200** | **Adv200** | **Prod\_Line200** |
| 0.70823806 | 0.78987722 | 0.91562984 | 0.87867725 | 0.64517534 | 0.78692085 |

| **Sales\_Image200** | **Pricing200** | **Warranty200** | **New\_Prod200** | **Ordering200** | **Del\_Speed200** |
| --- | --- | --- | --- | --- | --- |
| 0.86838362 | 0.66672098 | 0.91103133 | 0.12345337 | 0.77424332 | 0.92004281 |

Below, we see the rotated factor pattern where the high loading are bolded.

| **Rotated Factor Pattern (Standardized Regression Coefficients)** | | | | |
| --- | --- | --- | --- | --- |
|  | **Factor1** | **Factor2** | **Factor3** | **Factor4** |
| **Prod\_Qual200** | -0.13214 | 0.07332 | **0.86862** | 0.01015 |
| **Ecommerce200** | -0.05922 | **0.90549** | 0.01956 | 0.01638 |
| **Tech\_support200** | -0.01899 | -0.02858 | -0.04081 | **0.96795** |
| **Complaint200** | **0.95141** | -0.03545 | -0.02510 | 0.00715 |
| **Adv200** | 0.05467 | **0.79387** | 0.06121 | -0.07995 |
| **Prod\_Line200** | 0.49494 | 0.00477 | **0.61888** | 0.04924 |
| **Sales\_Image200** | 0.02272 | **0.90870** | -0.06532 | 0.06072 |
| **Pricing200** | 0.07303 | 0.09855 | **-0.80778** | -0.01247 |
| **Warranty200** | 0.02578 | 0.02780 | -0.00545 | **0.94708** |
| **New\_Prod200** | 0.11307 | 0.03972 | 0.30622 | -0.14866 |
| **Ordering200** | **0.88605** | 0.00565 | -0.05037 | 0.01044 |
| **Del\_Speed200** | **0.95101** | 0.04139 | -0.00773 | -0.01827 |

Which gives the same solution as earlier:

Factor 1: complaint, ordering, and delivery speed

Factor 2: ecommerce, advertising, and sales image

Factor 3: product quality, product line, and pricing

Factor 4: tech support and warranty

To build the summated scales, we will use the variables loaded on each factor. Factor 1 is the average of complaint, ordering and delivery speed. The reliability for scale 1 is measured by how close alpha is to 1.

| **Simple Statistics** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **N** | **Mean** | **Std Dev** | **Sum** | **Minimum** | **Maximum** |
| **Del\_Speed200** | 200 | 3.81600 | 0.74937 | 763.20000 | 1.60000 | 5.50000 |
| **Complaint200** | 200 | 5.36750 | 1.20996 | 1074 | 1.50000 | 8.70000 |
| **Ordering200** | 200 | 4.24200 | 0.91192 | 848.40000 | 1.20000 | 6.70000 |

| **Cronbach Coefficient Alpha** | |
| --- | --- |
| **Variables** | **Alpha** |
| Raw | 0.899866 |
| Standardized | 0.921909 |

| **Cronbach Coefficient Alpha with Deleted Variable** | | | | |
| --- | --- | --- | --- | --- |
| **Deleted Variable** | **Raw Variables** | | **Standardized Variables** | |
| **Correlation with Total** | **Alpha** | **Correlation with Total** | **Alpha** |
| **Del\_Speed200** | 0.891378 | 0.832053 | 0.884774 | 0.851291 |
| **Complaint200** | 0.852208 | 0.862545 | 0.859848 | 0.871950 |
| **Ordering200** | 0.775958 | 0.880243 | 0.781216 | 0.935075 |

The summated scales for factor 1 is the average of ecommerce, advertising and sales image. The reliability for scale 2 is less than that of scale 1.

| **Simple Statistics** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **N** | **Mean** | **Std Dev** | **Sum** | **Minimum** | **Maximum** |
| **Ecommerce200** | 200 | 3.76500 | 0.76892 | 753.00000 | 2.20000 | 5.70000 |
| **Sales\_Image200** | 200 | 5.24800 | 1.12857 | 1050 | 2.50000 | 8.20000 |
| **Adv200** | 200 | 4.06150 | 1.14706 | 812.30000 | 1.50000 | 6.90000 |

| **Cronbach Coefficient Alpha** | |
| --- | --- |
| **Variables** | **Alpha** |
| Raw | 0.824467 |
| Standardized | 0.842139 |

| **Cronbach Coefficient Alpha with Deleted Variable** | | | | |
| --- | --- | --- | --- | --- |
| **Deleted Variable** | **Raw Variables** | | **Standardized Variables** | |
| **Correlation with Total** | **Alpha** | **Correlation with Total** | **Alpha** |
| **Ecommerce200** | 0.715794 | 0.770495 | 0.717075 | 0.770558 |
| **Sales\_Image200** | 0.792104 | 0.636967 | 0.815527 | 0.671271 |
| **Adv200** | 0.609440 | 0.846300 | 0.598552 | 0.881572 |

Factor 3 is the average of product quality, product line and pricing where pricing2 is the reverse code for pricing.

| **Simple Statistics** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **N** | **Mean** | **Std Dev** | **Sum** | **Minimum** | **Maximum** |
| **Prod\_Qual200** | 200 | 7.89400 | 1.38301 | 1579 | 5.00000 | 10.00000 |
| **pricing2** | 200 | 3.02900 | 1.58125 | 605.80000 | 0 | 6.30000 |
| **Prod\_Line200** | 200 | 5.81500 | 1.31740 | 1163 | 2.30000 | 8.40000 |

| **Cronbach Coefficient Alpha** | |
| --- | --- |
| **Variables** | **Alpha** |
| Raw | 0.729830 |
| Standardized | 0.734704 |

| **Cronbach Coefficient Alpha with Deleted Variable** | | | | |
| --- | --- | --- | --- | --- |
| **Deleted Variable** | **Raw Variables** | | **Standardized Variables** | |
| **Correlation with Total** | **Alpha** | **Correlation with Total** | **Alpha** |
| **Prod\_Qual200** | 0.551956 | 0.643791 | 0.555988 | 0.651047 |
| **pricing2** | 0.535173 | 0.674350 | 0.535707 | 0.674878 |
| **Prod\_Line200** | 0.581316 | 0.615075 | 0.582859 | 0.618891 |

Factor 4 is the average of tech support and warranty

| **Simple Statistics** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **N** | **Mean** | **Std Dev** | **Sum** | **Minimum** | **Maximum** |
| **Tech\_support200** | 200 | 5.24300 | 1.65519 | 1049 | 0.40000 | 8.90000 |
| **Warranty200** | 200 | 6.04850 | 0.87535 | 1210 | 3.70000 | 8.40000 |

| **Cronbach Coefficient Alpha** | |
| --- | --- |
| **Variables** | **Alpha** |
| Raw | 0.818306 |
| Standardized | 0.911754 |

| **Cronbach Coefficient Alpha with Deleted Variable** | | | | |
| --- | --- | --- | --- | --- |
| **Deleted Variable** | **Raw Variables** | | **Standardized Variables** | |
| **Correlation with Total** | **Alpha** | **Correlation with Total** | **Alpha** |
| **Tech\_support200** | 0.837819 | . | 0.837819 | . |
| **Warranty200** | 0.837819 | . | 0.837819 | . |

The correlations between scales are as expected, either non-significant or too low to have practical significance because they are independent of each other.

| **Pearson Correlation Coefficients, N = 200 Prob > |r| under H0: Rho=0** | | | | |
| --- | --- | --- | --- | --- |
|  | **scale1** | **scale2** | **scale3** | **scale4** |
| **scale1** | 1.00000 | 0.31068 <.0001 | 0.28838 <.0001 | 0.17285 0.0144 |
| **scale2** | 0.31068 <.0001 | 1.00000 | -0.07896 0.2664 | 0.08188 0.2491 |
| **scale3** | 0.28838 <.0001 | -0.07896 0.2664 | 1.00000 | 0.15789 0.0256 |
| **scale4** | 0.17285 0.0144 | 0.08188 0.2491 | 0.15789 0.0256 | 1.00000 |