CHAPTER 5: MULTIVARIATE DATA ANALYSIS

The findings of basic analysis are valuable in their own right, as they provide background information for conducting further statistical analysis. For further analysis, illustrations in this chapter will be based on discriminant and factor analysis to understand the market structure for different types of users.

5.1 Demographic Differences in Network Service

As discussed previously in Research Methodology (Chapter 3.3.2.1), discriminant analysis is employed to determined the variables that are able to discriminate the dependent variables of pre- paid and post paid users. Stepwise discriminant analysis is used in this section to select a subset of predictors for inclusion in the discriminant function. Predictors variables in this method are entered sequentially, based on their ability to discriminate among the groups in the study. The results of running two groups stepwise discriminant analysis on the 70 percent analysis sample using SPSS are presented in the following tables. Some intuitive feel of the results may be obtained by examining the group means (Table 5.1a) and standard deviations (Table 5.1b).

Table 5.1a: Group Means

Network Service	Age Group	Ethnic Groups	Gender	Household Income	Personal Income	State
Post paid	5.76	1.73	1.30	5.08	3.68	5.90
Pre Paid	6.20	1.41	1.27	4.11	2.55	6.06
Total	5.83	1.67	1.29	4.91	3.49	5.92

Table 5.1b: Group Standard Deviations

Network Service	Age Group	Ethnic Groups	Gender	Household Income	Personal Income	State
Post paid	1.68	0.65	0.46	2.26	2.64	2.38
Pre Paid	1.83	0.66	0.44	2.07	0.98	2.54
Total	1.72	0.66	0.46	2.26	2.48	2.41

The pooled within- groups correlation matrix indicates low correlation between the predictors (Table 5.2). Multicollinearity is unlikely to be a problem. The significance of the univariate F- ratios indicates that when the predictors are considered individually, the variables that possibly able to discriminate between pre- paid and post paid are "Ethnic Groups", "Household Income", "Age Group" and "Personal Income". On the other hand, "State" and "Gender" are not likely being the factors for consideration as it is not significant (Table 5.3). These findings correlates to the exploratory results in Table 4.3

Table 5.2: Pooled Within- Groups Correlation Matrix

	Ethnic Groups	Gender	State	Household Income	Age Group	Personal Income
Ethnic Groups	1.00	-0.01	-0.08	0.09	0.02	0.09
Gender	-0.01	1.00	0.00	0.11	-0.10	0.08
State	-0.08	0.00	1.00	0.02	-0.01	0.00
Household Income	0.09	0.11	0.02	1.00	-0.03	0.29
Age Group	0.02	-0.10	-0.01	-0.03	1.00	0.04
Personal Income	0.09	0.08	0.00	0.29	0.04	1.00

Table 5.3: Wilks's Lambda (U- statistics) and Univariate F- ratio

	Wilks' Lambda	F	Sig.
Ethnic Groups	0.97	70.35	0.00
Gender	1.00	1.55	0.21
State	1.00	1.43	0.23
Household Income	0.97	57.26	0.00
Age Group	0.99	20.42	0.00
Personal Income	0.97	65.06	0.00

Since there are two groups, only one discriminant function is estimated. The eigenvalue associated with this function is 0.079 (Table 5.4). The canonical correlation associated with this function is 0.271. The square of this correlation, $(0.271)^2 = 0.073$, indicates that only 7.3 percent of the variance in the dependent variable (pre- paid / post paid) is explained, while the others (92.3%) were not been accounted in this model. The next step is to determine the significance of the discriminant function.

Table 5.4: Canonical Discriminant Functions

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1*	0.079	100	100	0.271

1* - First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	Df	Significance
1	0.927	164.795	4	0.000

The null hypothesis is that in the population, the means of all discriminant functions in all groups are equal and can be statistically tested. In SPSS this test is based on Wilks's Lambda (λ). If several functions are tested simultaneously, then Wilks's Lambda (λ) statistics will act as the test for univariate (λ) for each function. The significance level is estimated based on the chi- square transformation of the statistics.

In testing for significance in pre- paid and post paid mobile phone users, it is noted that the Wilks's Lambda (λ) associated with the function is 0.927, which transform to a chi- square of 164.795 with 4 degree of freedom. This is significance beyond the 0.05 level. Given the low multicollinearity scenario in the predictor variables, there should not be any unambiguous measures of the relative importance of these predictors in discriminating between the groups. With this caveat in mind, we can obtain some idea of the relative importance of the variables by examining the absolute magnitude of the standardized discriminant function coefficient.

Generally, predictors with relatively large standardized coefficients contribute more to the discriminating power of the function, as compared with predictors with smaller coefficient. The standardized canonical discriminant function coefficients are observed, as well as structure matrix and F-values are given in Table 5.5. The group centroids, giving the value of the discriminant function evaluated at the group means, are also shown (Table 5.6).

The stepwise results indicate that post paid mobile phone users group has a positive value, whereas pre- paid users group has a negative value. Ethnic group, personal income and household income are the predictors groups that have positive coefficients signs, in opposed to age group with negative sign. Apart from that, gender and state have been excluded from the prediction as they were not significant. This suggests that different ethic groups, higher personal income and household income are more likely to result in having a post paid mobile phone unit. It would be reasonable to develop a profile of two groups based on the predictors that seem to be important. However, this course of action needs to be justified with the other emerging findings that were discussed previously.

Table 5.5: Discriminant Function Coefficients

Variables	Standardized Weights	Discriminant Loading Value		Univariate F- ratio Value	
Ethnic Groups	0.573	0.641	(1)	70.353	(1)
Personal Income	0.470	0.616	(2)	65.064	(2)
Household Income	0.377	0.578	(3)	57.257	(3)
Age Group	-0.362	-0.345	(4)	20.416	(4)
Gender	NIL	0.108	(5)	1.551	(5)
State	NIL	-0.038	(6)	1.427	(6)

Table 5.6: Functions at Group Centroids

	Function
Post paid	0.126
Pre Paid	-0.622

5.1.1 Validation of Demographic Differences in Network Service

The next step is to analyze the sample for validation purposes. This is achieved by taking the observation between the analysis sample of 70 percent and the validation sample of 30 percent respondent.

These validation samples are analyzed in this section and often the distribution of the number of cases in the validation samples follows the distribution in the total sample. Table 5.7 indicates the summary of discriminant function coefficient for validation sample.

Table 5.7: Discriminant Function Coefficients (Validation Sample)

Variables	Standardized Weights	Discriminant Loading Value		Univariate F-ratio Value	
Ethnic Groups	0.545	0.624	(1)	50.439	(1)
Personal Income	0.426	0.573	(2)	42.589	(2)
Household Income	0.349	0.529	(3)	41.863	(3)
Age Group	-0.465	-0.476	(4)	23.192	(4)
Gender	NIL	0.106	(5)	0.124	(5)
State	NIL	-0.031	(6)	0.614	(6)

Comparing Table 5.7 and Table 5.5, it seems that there is little difference between the analyzed total samples with the validation sample. The results still suggest that "Gender" and "State" still been excluded after the stepwise process. Apart from that, "Ethnic Groups" is the number one factor that discriminate between the pre- paid and post paid users, followed by "Personal Income", "Household Income" and "Age Group". The results are consistent with earlier findings.

Table 5.8: Classification Results for Analysis Sample (70%)

		Group	Predicted Group Membership Post paid	Pre Paid	Total
Original	Count	Post paid	1165	188	1352
		Pre Paid	103	70	173
	%	Post paid	63.3	36.7	100
		Pre Paid	29.0	71.0	100
Cross-validated	Count	Post paid	1165	188	1352
		Pre Paid	103	70	173
	%	Post paid	63.3	36.7	100
		Pre Paid	29.0	71.0	100

62.5% of original grouped cases correctly classified.

Table 5.9: Classification Results for Validation Sample (30%)

		Group	Predicted Group Membership Post paid	Pre Paid	Total
Original	Count	Post paid	492	81	573
		Pre Paid	51	30	81
	%	Post paid	48.5	51.5	100
		Pre Paid	62.6	37.4	100
Cross-validated	Count	Post paid	492	81	573
		Pre Paid	51	30	81
	%	Post paid	48.5	51.5	100
		Pre Paid	62.6	37.4	100

63.6% of original grouped cases correctly classified.

Further validation is by investigating the classification results tables. The classification results for both analyzed and validation samples are shown in the above tables (Table 5.8 and Table 5.9). The hit ratio, or the percentage of cases correctly classified in the 70 percent analysis sample is 62.5 percent. One might suspect that this hit ratio is artificially inflated due to the fact that the data used for estimation. In the second part, by conducting the classification analysis on the 30 percent validation sample (Table 5.9), the hit ratio is 63.6 percent. Given the two groups of pre- paid and post paid users with unequal sizes, by chance one would expect a hit ratio of 368/2179 = 0.426, or 42.6 percent. Hence, the improvement over chance is more than 17 percent, and the validity of the discriminant analysis is judge as satisfactory.

Generally, the overall findings emerged from the above analysis indicate that network service phone users can be differentiated according to age group, race and users income. However, given the nature of low correlation index, or goodness- of- fit of the model (7.3%), these predictors may not be enough to develop a unique or complete user profiles. In view of this, it may not be necessary to further analyze these predictors, nor construct the customers record. In view of this, more in- depth investigation is needed to understand customer behavior from another business angle. One of the methods that is able to assist is to understand the importance of various product attributes to the general consumer.

5.2 Sources of Brand Preference

The next set of multivariate techniques is factor analysis. The procedure is choosen for this section because this technique will enable the grouping of all the brand attributes into groups of more manageable manner. Factor analysis was discussed in the previous chapter of Research Methodology (Chapter 3.3.2.2).

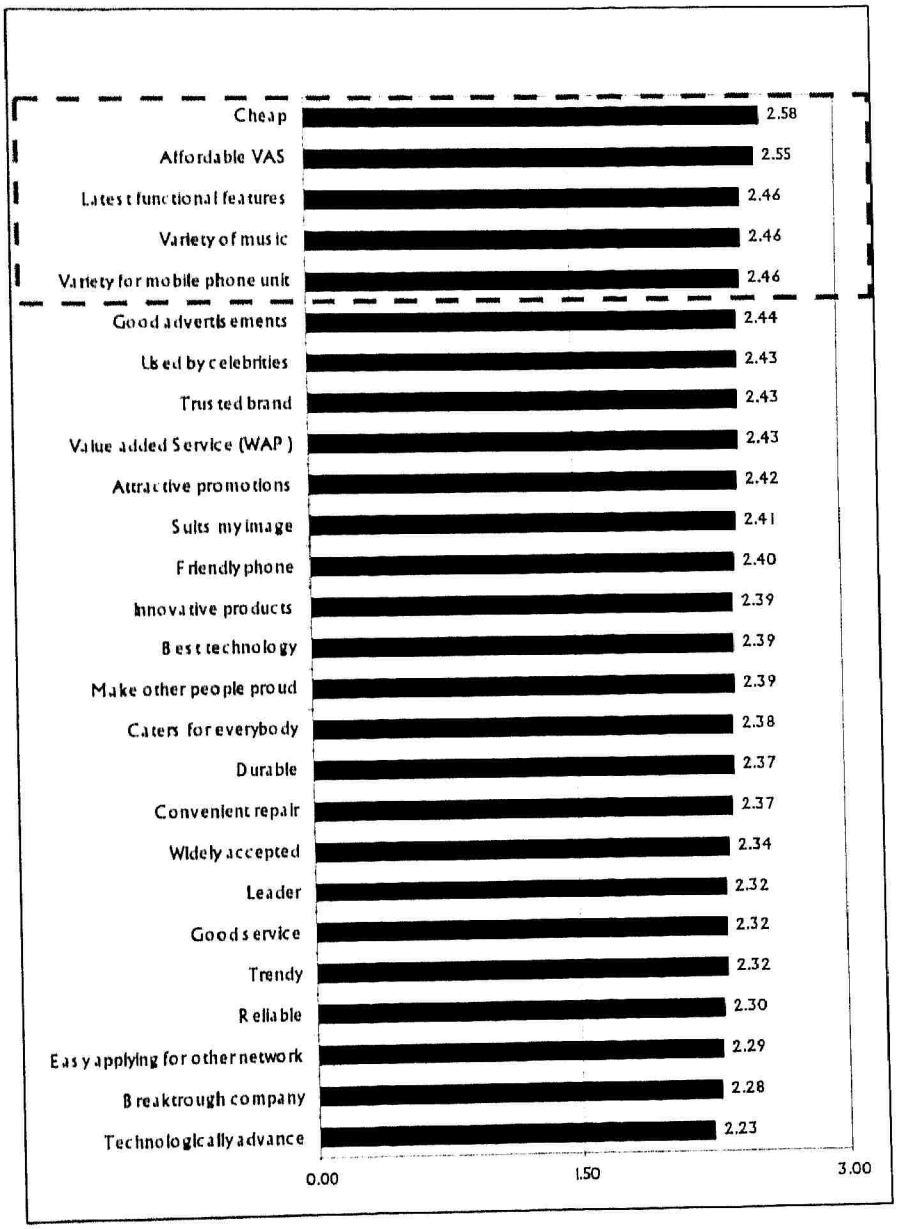
There are 26 product attributes for all the respondents to choose during the course of survey. These attributes serve as a good source of understanding the logic behind the preference index that was discussed previously (Chapter 4). In view of this, the attributes in data set will be coded accordingly to enable analysis.

Based on Graph 5.1, it seems that two of the top five most important attributes are somehow related to price. Apart from that, the functional features and variety of mobile phone unit are important for the respondents as well. It is important to note that these are the relative importance between the attributes, and it does not imply that the other attributes are not important. Where, the mean values for the other attributes are very close, between the range of 2.2 to 2.6. This strongly indicates that all these attributes are very important to the respondents, and due to the nature of survey, most of them should be highly correlated.

The assumption was tested out by using correlation analysis on the surveyed attributes (Appendix 8). The findings indicate that most attributes correlate significantly at 0.01 level (2-tailed). This shows that there is a high correlation between them, and it is possible to group them together. From the strategic point of view, it will be very difficult to take action based on the original attribute findings, as 26 product attributes are too large, and to invest into each of them for enhancement of marketing plan will prove to be very costly.

Based on these observation and consideration, an alternative procedure should be taken to further analyze these attributes.

Graph 5.1: Attributes Ranking



5.3 Managing Brand Attributes

As mentioned, during the survey, there were large numbers of variables or product attributes, and most of them seemed to be correlated. In this case, all these variables need to be summarized in a more manageable manner. For this exercise, factor analysis is considered because it is a procedure primarily used for data reduction or summarization (N. K. Malhotra, 1993). Where, it usually is able to assist in market segmentation for determining the underlying brand attributes that influence consumer choice. As mentioned in the introductory chapter (Chapter 1.4), the objectives of the project are to understand the competitor positioning and customer needs, which factor analysis can assist in conducting the grouping process to each of the studied brand for further understanding.

5.3.1 Understanding Brand Attributes - Nokia

The first issue in considering using factor analysis is to investigate if the attributes are suitable for the procedure by observing Barlett's test of sphericity and Kaiser- Meyer- Olkin (KMO) test measure of sampling adequacy. Based on the analysis done in Table 5.10, Barlett's test shows that the sample correlation matrix is significant. This finding supports the analysis in Appendix 8, where it further suggests that the product attributes, or variables are correlated in the sample. Apart from that, KMO test value of 0.97, suggests that it is appropriate to use factor analysis for the subsequent analysis. In view of this, factor analysis will be conducted for data reduction procedure.

Table 5.10: KMO and Barlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.97
Bartlett's Test of Sphericity	Approx. Chi-Square	207162.01
	Df	325
	Sig	0

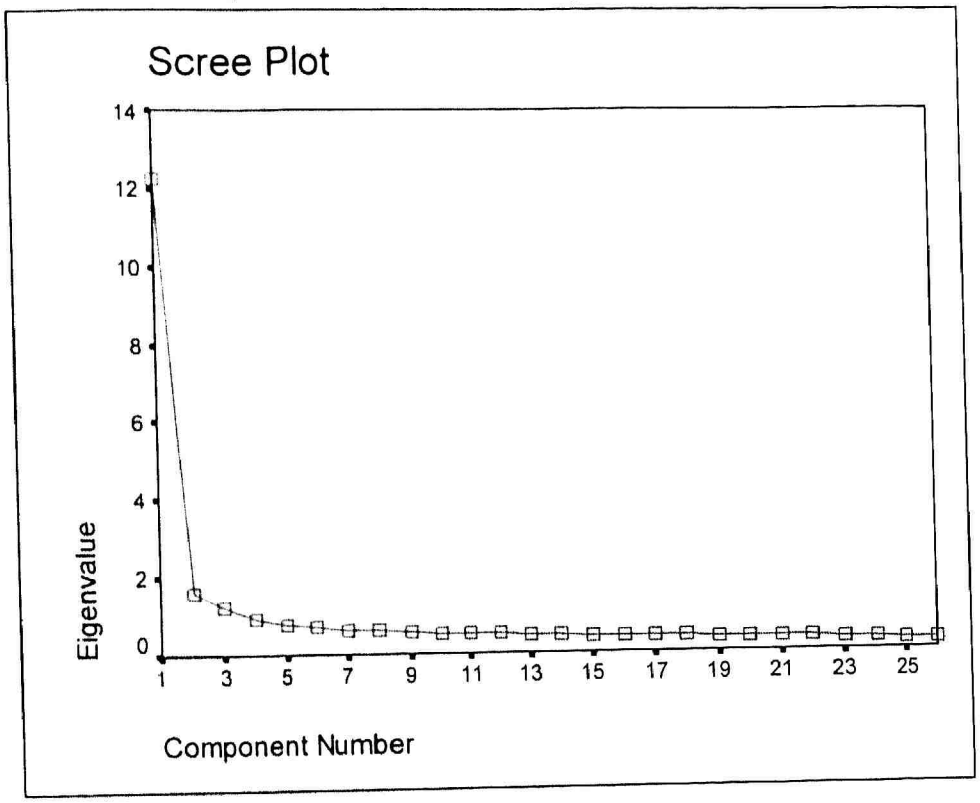
Sources of brand preference spring from having high levels of acceptance in brand associations, or attributes. These associations are normally measured using an attitude battery, which may either be binary or measured on the Likert scale. In order to investigate how well these variables move together, the first step is to determine the number of factors. An examination of eigenvalues, Scree Test, and interpretability will indicate the numbers that is needed to represent the original brand attributes. The Principal Components Method, using varimax rotation, reduced the 26 explanatory variables to 3 factors having eigenvalues greater than 1.0 (Table 5.11).

Table 5.11: Results for Extraction of Component Factors

Factor	Eigenvalue	% of Variance	Cumulative % of Variance
1	12.24	47.07	47.07
2	1.58	6.09	53.16
3	1.21	4.67	57.82
4	0.94	3.61	61.43
5	0.76	2.93	64.37
6	0.71	2.75	67.12
7	0.62	2.40	69.51
8	0.61	2.33	71.84
9	0.56	2.15	73.99
10	0.54	2.08	76.06
11	0.52	2.01	78.08
12	0.50	1.91	79.99
13	0.47	1.81	81.80
14	0.45	1.74	83.54
15	0.44	1.68	85.22
16	0.43	1.66	86.88
17	0.41	1.59	88.47
18	0.40	1.55	90.01
19	0.38	1.46	91.47
20	0.36	1.39	92.86
21	0.35	1.35	94.21
22	0.35	1.34	95.55
23	0.33	1.25	96.80
24	0.31	1.18	97.98
25	0.28	1.07	99.04
26	0.25	0.96	100.00

Looking at the Scree Test (whether there is a sudden drop off in the eigenvalues) we would either go with one factor (which explains over half of the variance) or with two, or three factors (Graph 5.2). Using the rule of eigenvalues which are more than 1.0, the graph recommends either two or three factors (which is quite aligned with the findings of Principal Component Analysis)

Graph 5.2: Scree Test for Component Analysis



Apart from using Scree Test to determine the number of factors, it is also useful to investigate how much each of there attributes these three factors are able to explain (in percentage term). The percentage variance explained by reducing the data from 26 attributes to 3 factors is shown in "Communality" column of Table 5.12. Again, it may be seen that these three factors are able to capture more than half of the variance in each of the attributes.

Apart from that, Table 5.12 also shows that unrotated component analysis factor matrix. Based on the loading pattern for all three factors, the first factor has the largest variance, where most of the variable having high loadings. This is expected as unrotated factor matrix will usually provide an unequal loading to the factors. Hence, it makes the subsequent interpretation difficult and less meaningful. Therefore, better results need to be obtained by using the rotated factor matrix as shown in Table 5.13.

Table 5.12: Unrotated Component Analysis Factor Matrix

	Factors			
	1	2	3	Communalities
A leader in telecommunication	0.70	-0.32	0.04	0.59
A reliable & trustworthy mobile phone unit	0.76	-0.14	0.03	0.59
Affordable value added services	0.60	0.41	0.29	0.61
Caters for everybody	0.70	-0.14	0.14	0.53
Contain latest functional features	0.70	0.27	-0.31	0.66
Convenient in applying with other telephone network	0.64	0.28	-0.17	0.51
Durable	0.66	0.33	-0.19	0.58
Easy / Convenient repair	0.74	-0.11	-0.33	0.68
Good sales / Customer service	0.75	-0.14	-0.33	0.68
Has good communication (advertisements, brochures, phamplets)	0.63	0.13	0.18	0.44
Is a friendly mobile phone unit provider	0.69	0.05	0.18	0.52
Is a mobile phone that able to make other people proud for it	0.73	-0.17	0.16	0.59
Is a mobile phone that suits my image	0.71	-0.20	0.01	0.55
Is a mobile phone that used by trendy people	0.70	-0.23	0.16	0.57
Is an excelling / breaktrough telecommunication company	0.72	-0.20	0.20	0.60
Is most often used by celebrities / superstar / person that I admire	0.70	-0.20	0.18	0.56
Is technologically advance	0.73	-0.19	0.20	0.61
Latest / Best technology	0.74	-0.14	-0.24	0.62
Offers affordable prices (cheaper for new model)	0.46	0.49	0.33	0.56
Offers wide range of value added services you need (WAP)	0.69	0.20	0.15	0.54
Promotions / Attractive plans	0.64	0.25	0.18	0.50
Provide innovative products & services	0.74	-0.12	0.20	0.60
This company has many variety for mobile phone unit	0.67	-0.17	-0.13	0.49
Trusted brand	0.61	0.38	-0.16	0.55
Wide variety of "beeping" tone / Music	0.68	0.34	-0.31	0.68
Widely accepted in Malaysia	0.67	-0.25	-0.31	0.61

Table 5.13 shows a different result by using rotated factor matrix. The matrix managed to pick up many different dimensions of the attributes as compared with the unrotated factor matrix in Table 5.12. Some differences that can be observed in Table 5.13 as compared with Table 5.12 are that the variance has been redistributed making the factor loadings, as well as the percentage for each variables different. Apart from that, it is simpler in explaining the output because the percent of variance within the factors are more evenly distributed. Also, there are no one variable that loads significantly on more than one factor. In view of these, it is clear that factor interpretation are better by using the rotated factor matrix, where in the subsequent section, only rotated factor matrix will be shown.

Table 5.13: Varimax Rotated Component Analysis Factor Matrix

	Factors			Communalities
	1	2	3	
A leader in telecommunication	0.72	0.27	0.10	0.59
A reliable & trustworthy mobile phone unit	0.64	0.35	0.26	0.59
Affordable value added services	0.25	0.18	0.72	0.61
Caters for everybody	0.63	0.23	0.28	0.53
Contain latest functional features	0.24	0.69	0.36	0.66
Convenient in applying with other telephone network	0.23	0.54	0.41	0.51
Durable	0.20	0.59	0.44	0.58
Easy / Convenient repair	0.51	0.64	0.08	0.68
Good sales / Customer service	0.53	0.63	0.07	0.68
Has good communication (advertisements, brochures, phamplets)	0.42	0.22	0.46	0.44
Is a friendly mobile phone unit provider	0.52	0.23	0.44	0.52
Is a mobile phone that able to make other people proud for it	0.68	0.22	0.29	0.59
Is a mobile phone that suits my image	0.64	0.33	0.18	0.55
Is a mobile phone that used by trendy people	0.69	0.20	0.23	0.57
Is an excelling / breakthrough telecommunication company	0.70	0.18	0.28	0.60
Is most often used by celebrities / superstar / person that I admire	0.68	0.18	0.26	0.56
Is technologically advance	0.70	0.19	0.29	0.61
Latest / Best technology	0.54	0.56	0.11	0.62
Offers affordable prices (cheaper for new model)	0.11	0.09	0.74	0.56
Offers wide range of value added services you need (WAP)	0.41	0.30	0.53	0.54
Promotions / Attractive plans	0.35	0.26	0.56	0.50
Provide innovative products & services	0.66	0.20	0.35	0.60
This company has many variety for mobile phone unit	0.55	0.43	0.11	0.49
Trusted brand	0.15	0.55	0.47	0.55
Wide variety of "beeping" tone / Music	0.18	0.70	0.40	0.68
Widely accepted in Malaysia	0.55	0.56	-0.04	0.61

The next step is to name the factor for more manageable interpretation. This is done by sorting the variables within the factors descendingly. Based on the results in Table 5.14, there are 12 attributes that loads strongly in factor one, suggesting that it is picking up on the different aspects of what it takes to be a good mobile phone. The second factor load nine attributes, and the third factor with only five.

Table 5.14: Naming the Factors

	Factor	Group
A leader in telecommunication	1	Best Technology & Image
Is technologically advance	1	
Is an excelling / breakthrough telecommunication company	1	
Is a mobile phone that used by trendy people	1	
Is most often used by celebrities / superstar / person that I admire	1	
Is a mobile phone that able to make other people proud for it	1	
Provide innovative products & services	1	
Is a mobile phone that suits my image	1	
A reliable & trustworthy mobile phone unit	1	
Caters for everybody	1	
This company has many variety for mobile phone unit	1	
Is a friendly mobile phone unit provider	1	
Wide variety of "beeping" tone / Music	2	Convenient Feature
Contain latest functional features	2	
Easy / Convenient repair	2	
Good sales / Customer service	2	
Durable	2	
Widely accepted in Malaysia	2	
Latest / Best technology	2	
Trusted brand	2	
Convenient in applying with other telephone network	2	
Offers affordable prices (cheaper for new model)	3	Valuable & Attractive
Affordable value added services	3	
Promotions / Attractive plans	3	
Offers wide range of value added services you need (WAP)	3	
Has good communication (advertisements, brochures, pamphlets)	3	

Based on the above observation, it seems that factor analysis suggests us to have three factors or dimensions to explain the large sum of original attributes. Apart from that, it is possible to provide names for these three factors. The name is very subjective, it depends on the examined attributes on each of the factor. Apart from that, for marketing purposes, the name of the factors grouping are also need to be simple, but comprehensive enough for the marketers to communicate to the relevant parties

As the first factor contained some of the strong attributes on leader in telecommunication, technological advance features, excelling telecommunication companies, used by other celebrities, etc., can denote it as "Best Technology and Image". The second factor which contained a variety of features, convenient repair, etc., can be denoted as "Convenient", and lastly the third factor as "Valuable and Attractive" because most of the attributes relates to the attractiveness of price and promotion.

The next step is to determine the model fit. A basic assumption underlying factor analysis is that the observed correlation between variables can be attributed to common factors. Hence, the correlation between the variables can be deduced or reproduced from the estimated correlation between the variables and the factors. The differences between the observed correlation or residuals are used to examine the fitness of that model. If there are many large residuals, the factor model does not provide a good fit to the data and the model should be reconsidered. In Appendix 9, we observed that only approximately 23 percent of the non-redundant residuals have the absolute values that are greater than 0.05, indicating an acceptable model fit.

5.3.2 Understanding Brand Attributes - Motorola

Based on the close correlation of attributes in Appendix 10 and the KMO test (Table 5.15) value of 0.98, the findings suggest that it is appropriate to use factor analysis for this brand.

Table 5.15: KMO and Barlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.98
Bartlett's Test of Sphericity	Approx. Chi-Square	32,242.68
	Df	325.00
	Sig.	0.00

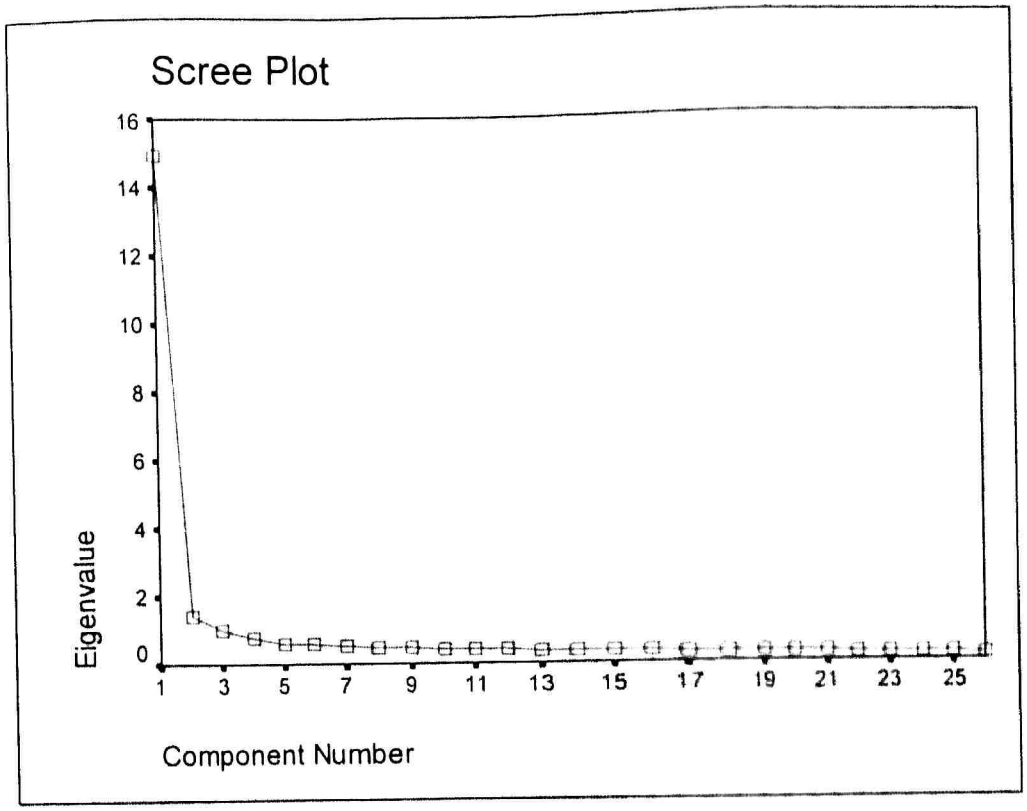
In order to investigate the number of grouping required for all the attributes, the step involved is to determine the number of factors by examining eigenvalues. The Principal Components Method, using varimax rotation to reduce the 26 explanatory variables is presented in Table 5.16. Based on the table, the first two factors have the eigenvalue of more than 1, which already incorporate approximately 62.9 percent of the studied attributes. On the other hand, the third factor has an eigenvalue of 0.98, which also suggest the possibility of having three factors for this section. Hence, further investigation by using Scree plot is required to verify the findings in Table 5.16.

Table 5.16: Results for Extraction of Component Factors

Factor	Eigenvalue	% of Variance	Cumulative % of Variance
1	14.92	57.39	57.39
2	1.43	5.51	62.91
3	0.98	3.75	66.66
4	0.76	2.92	69.58
5	0.59	2.25	71.83
6	0.57	2.19	74.02
7	0.51	1.96	75.98
8	0.49	1.90	77.88
9	0.47	1.83	79.71
10	0.42	1.60	81.31
11	0.41	1.58	82.88
12	0.39	1.50	84.39
13	0.38	1.45	85.83
14	0.37	1.44	87.27
15	0.35	1.36	88.63
16	0.34	1.29	89.93
17	0.31	1.20	91.13
18	0.31	1.19	92.32
19	0.29	1.10	93.42
20	0.29	1.10	94.52
21	0.27	1.03	95.55
22	0.26	0.99	96.54
23	0.25	0.97	97.51
24	0.24	0.93	98.44
25	0.22	0.85	99.28
26	0.19	0.72	100.00

Looking at the Scree Test and the rule of eigenvalues which are more than 1.0, the graph seems to recommends only two factors. Hence, based on the findings of Table 5.16, the third factor has also less than the required eigenvalues, it indicates that there will be two factors for Motorola in this analysis.

Graph 5.3: Scree Test for Component Analysis



The percentage variance explained by reducing the data from 26 attributes to 2 factors is captured in Table 5.17, where the factors are able to have more than half of the variance in each of the attributes

Table 5.17: Varimax Rotated Component Analysis Factor Matrix

	Factors		Communalities
	1	2	
A leader in telecommunication	0.79	0.27	0.70
A reliable & trustworthy mobile phone unit	0.69	0.44	0.66
Affordable value added services	0.29	0.72	0.60
Caters for everybody	0.68	0.39	0.62
Contain latest functional features	0.50	0.62	0.63
Convenient in applying with other telephone network	0.32	0.67	0.55
Durable	0.39	0.68	0.61
Easy - Convenient repair	0.74	0.38	0.69
Good sales / Customer service	0.75	0.36	0.70
Has good communication (advertisements, brochures, phamplets)	0.48	0.55	0.53
Is a friendly mobile phone unit provider	0.54	0.53	0.57
Is a mobile phone that able to make other people proud for it	0.71	0.40	0.66
Is a mobile phone that suits my image	0.74	0.32	0.66
Is a mobile phone that used by trendy people	0.73	0.35	0.66
Is an excelling / breakthrough telecommunication company	0.70	0.39	0.64
Is most often used by celebrities / superstar / person that I admire	0.70	0.34	0.61
Is technologically advance	0.74	0.37	0.68
Latest / Best technology	0.74	0.35	0.68
Offers affordable prices (cheaper for new model)	0.11	0.73	0.54
Offers wide range of value added services you need (WAP)	0.50	0.61	0.63
Promotions / Attractive plans	0.41	0.62	0.55
Provide innovative products & services	0.70	0.42	0.67
This company has many variety for mobile phone unit	0.74	0.27	0.63
Trusted brand	0.32	0.70	0.59
Wide variety of "beeping" tone / Music	0.43	0.67	0.63
Widely accepted in Malaysia	0.79	0.23	0.68

The findings in Table 5.17 indicate that the attributes can be summarized in two factors (consistent with Scree plots and eigenvalues findings). The first factor loads 16 attributes, and the second factors loads the remaining 10 attributes. In this case two factors / grouping for Motorola is enough in determining majority of the aspect of this mobile phone.

The next step for this brand is to determine the name for each of the factor. Sorting of attributes for this purpose is shown in Table 5.18. As this is a very subjective approach, the name for the first factor has been denoted as "Best Technology and Modern" due to the fact at majority respondents relates technologically advance, trendy, breakthrough company, e., to this brand. "Trusted and Affordable" has been denoted for the second factor because ıajority of the attributes concerns the price, value, trust, etc.

Table 5.18: Naming the Factors

	Factor	Group
A leader in telecommunication	1	Best Technology & Modern
Widely accepted in Malaysia	1	
Good sales / Customer service	1	
Is a mobile phone that suits my image	1	
Latest / Best technology	1	
This company has many variety for mobile phone unit	1	
Easy / Convenient repair	1	
Is technologically advance	1	
Is a mobile phone that used by trendy people	1	
Is a mobile phone that able to make other people proud for it	1	
Is most often used by celebrities / superstar / person that I admire	1	
Provide innovative products & services	1	
Is an excelling / breakthrough telecommunication company	1	
A reliable & trustworthy mobile phone unit	1	
Caters for everybody	1	
Is a friendly mobile phone unit provider	1	
Offers affordable prices (cheaper for new model)	2	Trusted & Affordable
Affordable value added services	2	
Trusted brand	2	
Durable	2	
Wide variety of "beeping" tone / Music	2	
Convenient in applying with other telephone network	2	
Promotions / Attractive plans	2	
Contain latest functional features	2	
Offers wide range of value added services you need (WAP)	2	
Has good communication (advertisements, brochures, pamphlets)	2	

Appendix 11, Reproduced Correlation, is the finding that is able to determine the fitness of the model. Based on the observation, there are approximately 20 percent of the non-redundant residuals having the absolute values that are greater than 0.05, indicating an acceptable model fit for Motorola factor analysis.

5.3.3 Understanding Brand Attributes - Ericsson

The consideration of using factor analysis for Ericsson was investigated based on the findings of correlation matrix in Appendix 12, as well as the Barlett's test of sphericity and Kaiser-Meyer- Olkin (KMO) test in Table 5.19. Appendix 12 indicates that there are high correlation between the product attributes, which suggest the possibility of engaging factor analysis for the data. KMO test value of 0.98, provides further confirmation of the appropriateness for applying the analysis.

Table 5.19: KMO and Barlett's Test

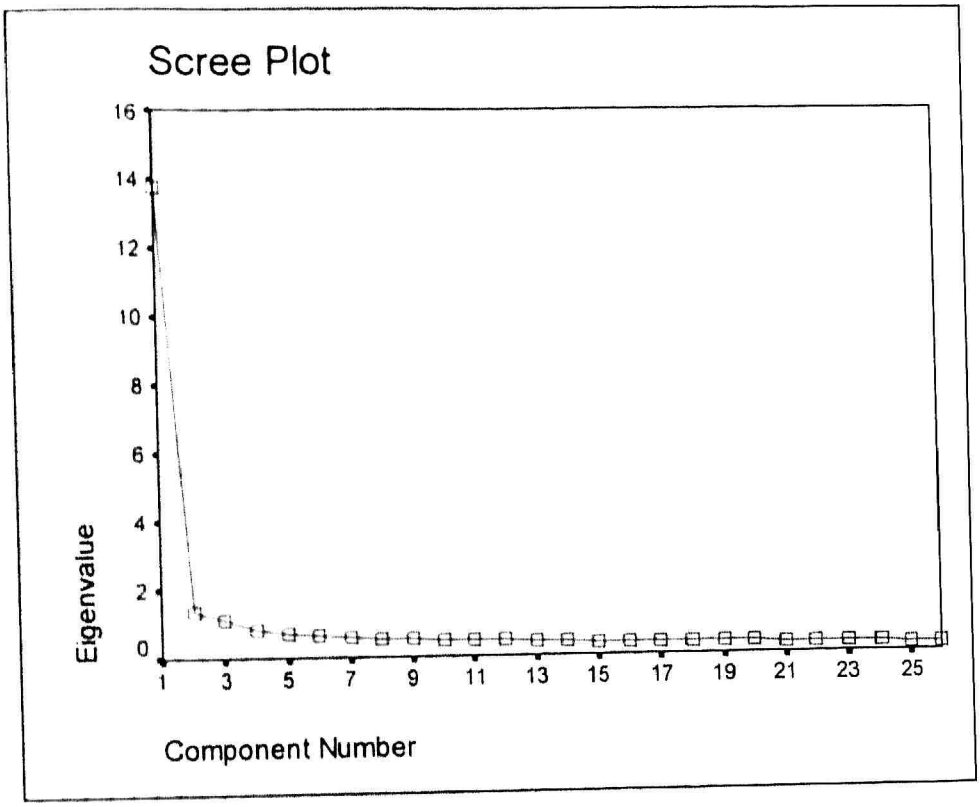
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.98
Bartlett's Test of Sphericity	Approx. Chi-Square	39,118.73
	Df	325.00
	Sig.	0.00

Eigenvalues are the main platform used to determine the total number of factor for the attributes grouping. This is done mainly by observing the findings in Table 5.20 and Graph 5.4. The information is shown in Table 5.20, reduces the 26 explanatory attributes to 3 factors with an eigenvalue of more than 1. The three factors have managed to incorporate approximately 62.5 percent of the total studied attributes. This is further indicated in the Scree plots (Graph 5.4), where it clearly shows that for this brand a total of 3 factors are needed for factor analysis.

Table 5.20: Results for the Extraction of Component Factors

Factor	Eigenvalue	% of Variance	Cumulative % of Variance
1	13.78	52.98	52.98
2	1.34	5.16	58.14
3	1.13	4.36	62.50
4	0.81	3.11	65.60
5	0.71	2.74	68.35
6	0.65	2.48	70.83
7	0.59	2.25	73.08
8	0.53	2.05	75.13
9	0.50	1.92	77.06
10	0.49	1.90	78.96
11	0.48	1.85	80.80
12	0.45	1.74	82.55
13	0.42	1.62	84.16
14	0.39	1.49	85.66
15	0.37	1.44	87.10
16	0.37	1.41	88.51
17	0.35	1.36	89.87
18	0.34	1.32	91.20
19	0.33	1.29	92.48
20	0.33	1.27	93.76
21	0.32	1.24	94.99
22	0.31	1.19	96.18
23	0.27	1.04	97.23
24	0.27	1.03	98.26
25	0.24	0.92	99.19
26	0.21	0.81	100.00

Graph 5.4: Scree Test for Component Analysis



Based on the findings of Table 5.21, "Communality" value seems to indicate that by reducing the attributes, the percentage variance explained is able to capture more than half of the variance in each of the attributes.

Table 5.21: Varimax Rotated Component Analysis Factor Matrix

	Factors			Communalities
	1	2	3	
A leader in telecommunication	0.57	0.21	0.47	0.59
A reliable & trustworthy mobile phone unit	0.60	0.39	0.32	0.61
Affordable value added services	0.47	0.60	0.14	0.60
Caters for everybody	0.54	0.31	0.43	0.57
Contain latest functional features	0.23	0.64	0.47	0.69
Convenient in applying with other telephone network	0.25	0.71	0.17	0.59
Durable	0.24	0.71	0.29	0.64
Easy / Convenient repair	0.30	0.38	0.69	0.71
Good sales / Customer service	0.30	0.35	0.72	0.72
Has good communication (advertisements, brochures, phamplets)	0.48	0.49	0.25	0.53
Is a friendly mobile phone unit provider	0.60	0.45	0.18	0.60
Is a mobile phone that able to make other people proud for it	0.68	0.30	0.32	0.65
Is a mobile phone that suits my image	0.65	0.19	0.36	0.59
Is a mobile phone that used by trendy people	0.70	0.27	0.29	0.65
Is an excelling / breakthrough telecommunication company	0.71	0.30	0.23	0.64
Is most often used by celebrities / superstar / person that I admire	0.62	0.25	0.29	0.53
Is technologically advance	0.70	0.27	0.30	0.66
Latest / Best technology	0.32	0.30	0.71	0.69
Offers affordable prices (cheaper for new model)	0.41	0.59	0.10	0.53
Offers wide range of value added services you need (WAP)	0.55	0.54	0.21	0.64
Promotions / Attractive plans	0.42	0.54	0.23	0.53
Provide innovative products & services	0.65	0.32	0.36	0.65
This company has many variety for mobile phone unit	0.35	0.18	0.68	0.61
Trusted brand	0.22	0.73	0.26	0.64
Wide variety of "beeping" tone / Music	0.22	0.70	0.42	0.71
Widely accepted in Malaysia	0.32	0.16	0.74	0.68

The above observations have helped to indicate the total of factors in this analysis. Hence, the Rotated Factor Pattern Matrix managed to segment the 26 attributes into three main group as per indicated in Table 5.22, denoted as "Trendy and Innovation" for the first factor, followed by "Trusted and Valuable", and lastly "Good Services". Again, the name of the factor grouping is very subjective, but the main objective is to be able to summarize the attributes into some manageable and simple statements / wordings.

Table 5.22: Naming the Factors

	Factor	Group
Is an excelling breakthrough telecommunication company	1	Trendy & Innovation
Is technologically advance	1	
Is a mobile phone that used by trendy people	1	
Is a mobile phone that able to make other people proud for it	1	
Is a mobile phone that suits my image	1	
Provide innovative products & services	1	
Is most often used by celebrities superstar / person that I admire	1	
Is a friendly mobile phone unit provider	1	
A reliable & trustworthy mobile phone unit	1	
A leader in telecommunication	1	
Offers wide range of value added services you need (WAP)	1	
Caters for everybody	1	
Trusted brand	2	Trusted & Valuable
Durable	2	
Convenient in applying with other telephone network	2	
Wide variety of "beeping" tone / Music	2	
Contain latest functional features	2	
Affordable value added services	2	
Offers affordable prices (cheaper for new model)	2	
Promotions / Attractive plans	2	
Has good communication (advertisements, brochures, pamphlets)	2	
Widely accepted in Malaysia	3	Good Services
Good sales / Customer service	3	
Latest / Best technology	3	
Easy / Convenient repair	3	
This company has many variety for mobile phone unit	3	

The fitness of model is examined in Appendix 13, where approximately 18 percent of the non- redundant residuals have the absolute values that are greater than 0.05, indicating an acceptable model fit.

5.3.4 Understanding Brand Attributes - Samsung

Close correlation of attributes are observed in Appendix 12. KMO and Barlett's test are also been considered to further evaluate the appropriateness of using factor analysis. In this case, KMO test value (Table 5.23) of 0.97, and high significance level of Barlett's test suggest that it is appropriate to use analysis for Samsung.

Table 5.23: KMO and Barlett's Test

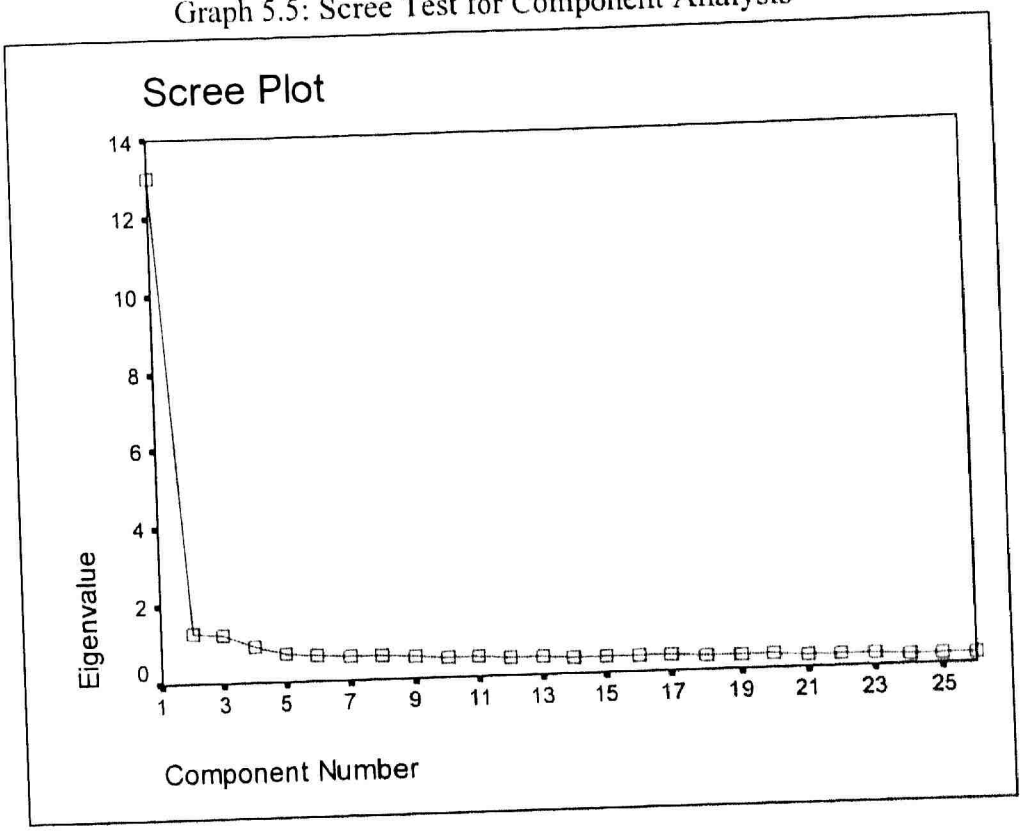
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.97
Bartlett's Test of Sphericity	Approx. Chi-Square	35,584.61
	df	325.00
	Sig.	0.00

Based on the eigenvalues in Principal Components Method, using varimax rotation to reduce the 26 explanatory variable and the Scree plot, it suggests that it is possible to reduce the 26 attributes into 3 groups. In this case, Table 5.24 indicates that by having 3 factors, it has already incorporates close to 60 percent of the studied attributes. The findings are quite aligned with Scree plots in Graph 5.5.

Table 5.24: Results for Extraction of Component Factors

Factor	Eigenvalue	% of Variance	Cumulative % of Variance
1	13.03	50.13	50.13
2	1.28	4.91	55.04
3	1.22	4.69	59.73
4	0.90	3.48	63.21
5	0.74	2.85	66.06
6	0.65	2.48	68.54
7	0.62	2.39	70.94
8	0.59	2.28	73.21
9	0.56	2.15	75.36
10	0.52	2.01	77.38
11	0.50	1.91	79.29
12	0.48	1.83	81.12
13	0.45	1.73	82.85
14	0.43	1.65	84.50
15	0.42	1.60	86.10
16	0.40	1.53	87.63
17	0.39	1.49	89.11
18	0.38	1.45	90.56
19	0.37	1.43	92.00
20	0.35	1.36	93.36
21	0.33	1.29	94.65
22	0.32	1.23	95.87
23	0.30	1.16	97.04
24	0.28	1.06	98.09
25	0.26	0.99	99.09
26	0.24	0.91	100.00

Graph 5.5: Scree Test for Component Analysis



The percentage variance explained by reducing the data from 26 attributes to 3 factors is captured in Table 5.25, where the varimax rotated factor matrix been presented.

Table 5.25: Varimax Rotated Component Analysis Factor Matrix

	Factors			Communalities
	1	2	3	
A leader in telecommunication	0.63	0.19	0.40	0.59
A reliable & trustworthy mobile phone unit	0.65	0.32	0.29	0.62
Affordable value added services	0.41	0.59	0.15	0.54
Caters for everybody	0.60	0.28	0.35	0.55
Contain latest functional features	0.23	0.68	0.38	0.66
Convenient in applying with other telephone network	0.27	0.67	0.20	0.56
Durable	0.24	0.68	0.29	0.61
Easy / Convenient repair	0.33	0.36	0.65	0.65
Good sales / Customer service	0.31	0.35	0.68	0.69
Has good communication (advertisements, brochures, phamplets)	0.42	0.50	0.16	0.45
Is a friendly mobile phone unit provider	0.64	0.40	0.16	0.59
Is a mobile phone that able to make other people proud for it	0.70	0.28	0.30	0.65
Is a mobile phone that suits my image	0.63	0.24	0.40	0.61
Is a mobile phone that used by trendy people	0.69	0.27	0.26	0.62
Is an excelling / breakthrough telecommunication company	0.69	0.30	0.20	0.60
Is most often used by celebrities / superstar / person that I admire	0.58	0.26	0.31	0.49
Is technologically advance	0.71	0.33	0.26	0.68
Latest / Best technology	0.30	0.28	0.71	0.67
Offers affordable prices (cheaper for new model)	0.43	0.53	0.09	0.47
Offers wide range of value added services you need (WAP)	0.49	0.56	0.19	0.60
Promotions / Attractive plans	0.43	0.54	0.20	0.52
Provide innovative products & services	0.67	0.32	0.24	0.61
This company has many variety for mobile phone unit	0.24	0.18	0.71	0.59
Trusted brand	0.24	0.68	0.24	0.59
Wide variety of "beeping" tone / Music	0.21	0.72	0.35	0.68
Widely accepted in Malaysia	0.28	0.19	0.72	0.62

Table 5.26 indicates that the summarized attributes in each of the factored grouping. In order to have more manageable and simpler statements, each of the factor will be denoted according to the attributes contained

Table 5.26: Naming the Factors

Is technologically advance	1	Advanced & Trendy
Is a mobile phone that able to make other people proud for it	1	
Is a mobile phone that used by trendy people	1	
Is an excelling / breakthrough telecommunication company	1	
Provide innovative products & services	1	
A reliable & trustworthy mobile phone unit	1	
Is a friendly mobile phone unit provider	1	
A leader in telecommunication	1	
Is a mobile phone that suits my image	1	
Caters for everybody	1	
Is most often used by celebrities / superstar / person that I admire	1	
Wide variety of "beeping" tone / Music	2	Value Features
Trusted brand	2	
Durable	2	
Contain latest functional features	2	
Convenient in applying with other telephone network	2	
Affordable value added services	2	
Offers wide range of value added services you need (WAP)	2	
Promotions / Attractive plans	2	
Offers affordable prices (cheaper for new model)	2	
Has good communication (advertisements, brochures, pamphlets)	2	
Widely accepted in Malaysia	3	Convenient Services
Latest / Best technology	3	
This company has many variety for mobile phone unit	3	
Good sales / Customer service	3	
Easy / Convenient repair	3	

Based on the attributes contained in the first factor, it is denoted as "Advanced and Trendy" because majority of the attributes are indicated for trendy people, breakthrough companies, innovation, etc. The second factor been denoted as "Value Features" for the high rating within the grouping for functional features, promotion plans, etc. The third factor as "Convenient Services" due to the fact that it is widely accepted with good services and repair.

Reproduced Correlation in Appendix 15 indicates that this factor analysis model is quite fit for Samsung because there are approximately 21 percent of the non- redundant residuals having the absolute values that are greater than 0.05.

5.3.5 Understanding Brand Attributes - Alcatel

In order to determine the suitability of using factor analysis for Alcatel, the first initiative is to observe the findings of correlation matrix in Appendix 16. The observation indicates that most of the attributes are closely correlated. This finding is further confirmed with other statistical tests i.e., Barlett's test (which is highly significant) and KMO test (0.98) in Table 5.27. Hence, based on this observation, it seems that it is appropriate to conduct factor analysis for this brand.

Table 5.27: KMO and Barlett's Test

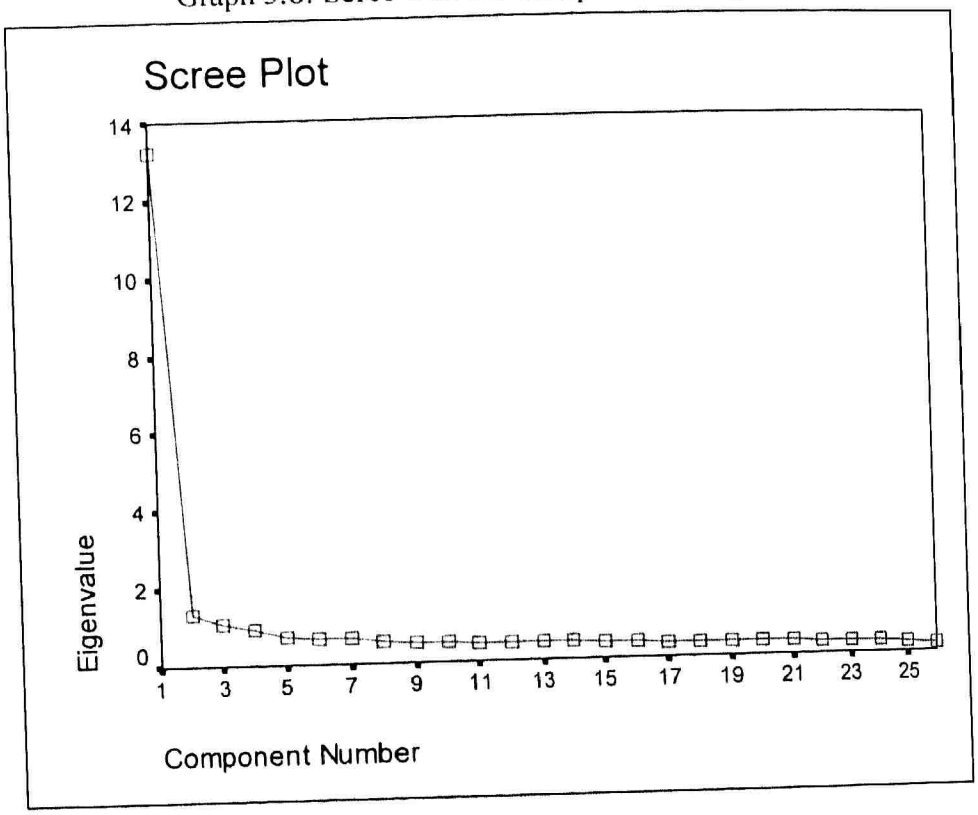
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.98
Bartlett's Test of Sphericity	Approx. Chi-Square	36,119.80
	df	325.00
	Sig.	0.00

The next step is to determine the number of grouping or factor that these attributes will generate by investigating the eigenvalues and Scree plot. Table 5.28 indicates that the possibility of three factors grouping for the attributes, which comprised of approximately 60 percent of the total studied attributes. This is further shown in the Scree plots (Graph 5.6), where it also shows that for this brand a total of 3 factors will be produced in factor analysis.

Table 5.28: Results for the Extraction of Component Factors

Factor	Eigenvalue	% of Variance	Cumulative % of Variance
1	13.23	50.88	50.88
2	1.32	5.07	55.95
3	1.06	4.08	60.02
4	0.91	3.49	63.52
5	0.70	2.70	66.22
6	0.68	2.60	68.82
7	0.65	2.51	71.33
8	0.56	2.15	73.48
9	0.53	2.02	75.50
10	0.52	1.99	77.49
11	0.48	1.85	79.34
12	0.46	1.78	81.12
13	0.46	1.76	82.88
14	0.44	1.68	84.56
15	0.41	1.57	86.13
16	0.40	1.55	87.68
17	0.38	1.47	89.15
18	0.37	1.43	90.58
19	0.36	1.37	91.96
20	0.35	1.33	93.29
21	0.34	1.30	94.58
22	0.32	1.24	95.83
23	0.31	1.21	97.04
24	0.29	1.10	98.14
25	0.25	0.98	99.11
26	0.23	0.89	100.00

Graph 5.6: Scree Test for Component Analysis



Further examination of the factor grouping indicates that by reducing the attributes, the percentage variance explained is able to capture more than half of the variance in each of the attributes. This is shown in Table 5.29

Table 5.29: Varimax Rotated Component Analysis Factor Matrix

	Factors			Communalities
	1	2	3	
A leader in telecommunication	0.60	0.19	0.47	0.62
A reliable & trustworthy mobile phone unit	0.59	0.32	0.42	0.62
Affordable value added services	0.35	0.70	0.09	0.62
Caters for everybody	0.60	0.34	0.35	0.60
Contain latest functional features	0.19	0.60	0.49	0.64
Convenient in applying with other telephone network	0.27	0.51	0.39	0.49
Durable	0.24	0.58	0.48	0.62
Easy / Convenient repair	0.34	0.31	0.70	0.70
Good sales / Customer service	0.37	0.25	0.73	0.73
Has good communication (advertisements, brochures, phamplets)	0.38	0.51	0.22	0.45
Is a friendly mobile phone unit provider	0.55	0.44	0.26	0.56
Is a mobile phone that able to make other people proud for it	0.68	0.29	0.25	0.61
Is a mobile phone that suits my image	0.63	0.27	0.34	0.58
Is a mobile phone that used by trendy people	0.70	0.24	0.29	0.63
Is an excelling / breaktrough telecommunication company	0.70	0.27	0.27	0.63
Is most often used by celebrities / superstar / person that I admire	0.61	0.33	0.27	0.56
Is technologically advance	0.72	0.25	0.27	0.65
Latest / Best technology	0.37	0.25	0.67	0.64
Offers affordable prices (cheaper for new model)	0.26	0.68	0.06	0.54
Offers wide range of value added services you need (WAP)	0.42	0.64	0.17	0.62
Promotions / Attractive plans	0.37	0.59	0.22	0.53
Provide innovative products & services	0.67	0.35	0.21	0.62
This company has many variety for mobile phone unit	0.42	0.23	0.53	0.51
Trusted brand	0.16	0.56	0.38	0.49
Wide variety of "beeping" tone / Music	0.15	0.65	0.46	0.66
Widely accepted in Malaysia	0.40	0.16	0.68	0.65

Rotated Factor Pattern Matrix has helped to confirm the total number of factors grouping, and at the same time collect the attributes with close correlation to each of the grouping. Based on the attributes contained in Table 5.30, the first factor is denoted as "Breakthrough Image and Technology" because most of the attributes indicates technology advance, trendy, etc.

The second factor been denoted as "Valuable Features" due to the fact that the attributes are referring to latest functional features, affordable value and prices, attractive promotions, etc. "Good Services" is the name given to the third factor as most of the attributes are referring to services, repair, convenient, etc.

Table 5.30: Naming the Factors

	Factor	Group
Is technologically advance	1	Breakthrough Image & Technology
Is a mobile phone that used by trendy people	1	
Is an excelling / breakthrough telecommunication company	1	
Is a mobile phone that able to make other people proud for it	1	
Provide innovative products & services	1	
Is a mobile phone that suits my image	1	
Is most often used by celebrities / superstar / person that I admire	1	
A leader in telecommunication	1	
Caters for everybody	1	
A reliable & trustworthy mobile phone unit	1	
Is a friendly mobile phone unit provider	1	
Affordable value added services	2	Valuable Features
Offers affordable prices (cheaper for new model)	2	
Wide variety of "beeping" tone / Music	2	
Offers wide range of value added services you need (WAP)	2	
Contain latest functional features	2	
Promotions / Attractive plans	2	
Durable	2	
Trusted brand	2	
Convenient in applying with other telephone network	2	
Has good communication (advertisements, brochures, pamphlets)	2	
Good sales / Customer service	3	Good Services
Easy / Convenient repair	3	
Widely accepted in Malaysia	3	
Latest / Best technology	3	
This company has many variety for mobile phone unit	3	

Model fit is examined in Appendix 17, where approximately 21 percent of the non- redundant residuals have the absolute values that are greater than 0.05, indicating an acceptable fit.

5.4 Chapter Summary

Based on the above findings and observation, it seems that each of the brands has its own selling points. Discriminant analysis indicates that market segmentation for pre- paid and postpaid users are possible with the variables, "Ethnic Groups", "Personal Income", "Household Income" and "Age Group".

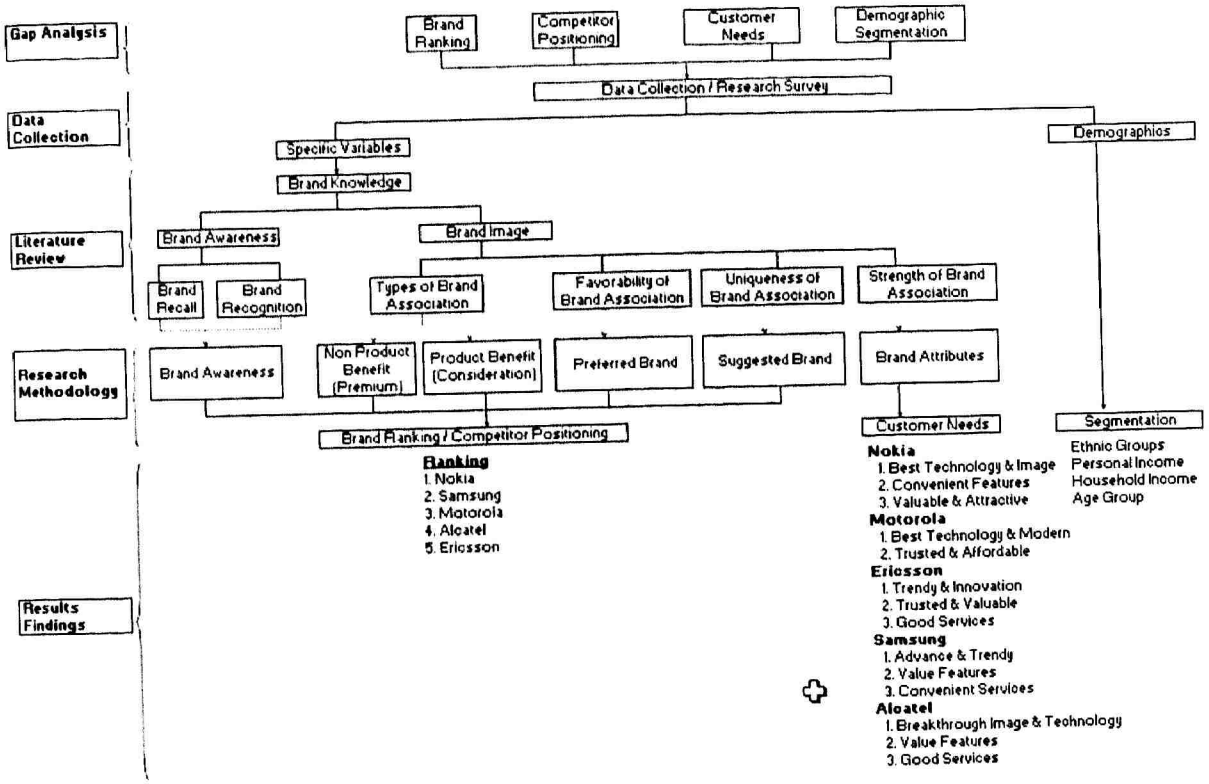
Apart from that factor analysis assist in grouping the brand attributes for each of the studied brand. Varimax rotated component analysis factor matrix is use to explain the observation results for each of the studied brand. In view of this, for easier comparison the following table (Table 5.31) providing the summary of the analysis.

Table 5.31: Summary – Naming the Factors for Each Brand

	Nokia	Motorola	Ericsson	Samsung	Alcatel
1	Best Technology & Image	Best Technology & Modern	Trendy & Innovative	Advance & Trendy	Breakthrough Image & Technology
2	Convenient Features	Trusted & Affordable	Trusted & Valuable	Value Features	Value Features
3	Valuable & Attractive		Good Services	Convenient Services	Good Services

Figure 5.1 is the summary workflow and relationship from the beginning of the project until the latest findings. It provides a good glimpse for the project.

Figure 5.1: Chapters Summary



The above observation managed to assist further understanding of these 26 attributes by summarizing them into the underlying dimensions. This is much more economical and interpretable for anyone compared to looking solely at each 26 attributes. In addition to associations which have been measured, the brand preference indexes in Chapter 4 also provide a good understanding of the brand position in the market.

CHAPTER 6: CONCLUSION and RECOMMENDATION

6.1 **Business Findings**

6.2 **Marketing Strategy**

6.3 **Post Research**