

## Perceptual map for customer preferences of car brands using multi dimensional scaling

G. MANIMANNAN<sup>1</sup>, P. SANDHYA<sup>2</sup> AND R. NISHANTHI<sup>3</sup>

<sup>1</sup> Assistant Professor, Department of Statistics, DRBCCC Hindu College, Chennai-72

<sup>2,3</sup> Senior Graduate Students, Department of Statistics, DRBCCC Hindu College, Chennai-72

**Abstract:** This research attempts to identify customer preferences among various car brands. The primary database was collected from Tambaram Municipality using simple random sampling method. The total samples 300 were collected from different customers, the questionnaire divided into two sections, they are (i) demographic details and customer preference like, price, performance, brand name, colors, etc. The main objectives of this research paper to identify which brand has attracted more number of customers. The application of multidimensional scaling establishes the results of their scores on two dimensions and conclude that Maruti got the first position based on their price and performance, currently a good *brand image*, but brands like Hyundai and Ford possess second third positions respectively. Ford and Hyundai attract the customers on the basis of price perceptions. The perceptual map shows, brands like, Hyundai and Ford perceived to be similar, whereas Maruti is a standalone brand.

**Keywords:** Perception, customers, Multi Dimensional Scaling (MDS) and Perceptual Map

### 1.0 Introduction

Market Research is a complete analysis of a particular market. This is very vital to identify the various factors like taste and preferences of consumers, their economic, social, cultural dimensions etc. Market research is a watch dog which is signal to the organization about any change that may affect it. Thus it is a continuous process.

Marketing research is the function which links the consumer, customer, and public to the marketer through the information, the information used to identify and define marketing opportunities and problems; generate, refine, and evaluate marketing actions; monitor marketing performance; and improve understanding of marketing as a process. Marketing research specifies the information required to address these issues; designs the method for collecting information; manages and implements the data collection process; analyzes the results, and communicates the findings and their implication (Dik W. Twedt, Ed., 1983).

Outstanding marketing companies go to great lengths to learn about and understand their consumer's needs, wants and demands. They conduct customer research about consumer likes and dislikes. Understanding this in detail provides important inputs for designing marketing strategies. Thus market research plays an important role in studying the preferences of customers (Rajendra Nargundakar, 2005). The main objectives of this research paper to identify which brands of cars to prefer more in the market using Multi Dimensional Scaling (MDS) and Perceptual Map.

### 2.0 Review of Literature

Market research play vital role in India and also huge number of research attempted and concluded various aspects of results. Multi Dimensional Scaling and Perceptual Map to easily identify perceptual map to visualize the results of MDS dimension for customers. The

following literatures are used MDS for various purpose of research. In contrast to deterministic MDS models, most probabilistic models are able to test hypotheses, to distinguish between variation and distance, and to explicitly estimate the variance associated with a particular stimulus, distance or dimension. These properties should be of importance to all MDS users. To the user who sees MDS primarily as a data reduction tool (Stefflre 1972), most probabilistic MDS methods offer the advantage of estimates with desirable maximum likelihood properties. If, on the other hand, one sees MDS and a measurement model that expresses a theory, albeit a primitive and globalist one, about the data-generating process (Roskarn 1981), then probabilistic MDS methods additionally offer the potential of expanding our understanding of how people process and respond to complex stimuli.

Researchers and marketers have long used perceptual mapping as a powerful device for interpreting and communicating insights about market structure. Its applications have primarily focused on understanding how brands compete in terms of delivering benefits. The last twenty years seem to have produced considerable development in the ease of use of a variety of mapping techniques, better assessments of the strengths and weaknesses of each technique, and far more elegant graphic presentations of results. Far less energy and creativity have been devoted to developing new applications for perceptual mapping or dealing with the perceptual psychology of marketing managers who must utilize the results of Multidimensional Scaling (MDS).

One new application of MDA-based mapping is the measurement of brand equity. Understanding brand equity has become increasingly important as the mergers and acquisitions activities of the last decade has resulted in a recognition that many companies' brand names are substantially undervalued. One common problem with MDA-based mapping comes from a perceptual misunderstanding. As marketing managers begin to understand a perceptual map, they invariably ask: -What does the middle of the map mean? They are rarely satisfied with the appropriate answer, namely that the center is simply the average of the products rated, because the center has *no marketing meaning*. This is often unsettling as they are confronted with a fascinating visual whose focal point has little or no meaning.

### 3.0 Database

This research paper database were collected Tambaram Municipality is divided into 39 wards. The researcher have considered all the wards and used random number tables to select the samples from each ward using simple random sampling method. In this study, the targeted population samples are fixed among car users based on sampling methods. Finally, the researchers collect 300 samples from various brands of car customers. In this connection, the familiar statistical method of Multi Dimensional Scaling (MDS) used to identify customer preferences. In this paper, we have considered more familiar brands of car like, MARUTI, FORD, TATA, HYUNDAI, MAHINDRA and CHEVROLET. Majority of the customers are preferences like price, performance, color, appearance and comfort. The investigators are visited different areas of Tambaram Municipality and collected the primary data using questionnaire.

### 4.0 Methodology

#### 4.1 Multidimensional Scaling

Multidimensional (MDS), also known as perceptual mapping, is a procedure that enables a

researcher to determine the perceived relative image of set of objects (firms, products, ideas or other items associated with commonly held perceptions). The purpose of MDS is to transform consumer judgments of overall similarity or preferences into distances represented in multidimensional space. Multidimensional scaling based on the comparison of objects, MDS differs from other multivariate statistical technique in that it uses only a single, overall measure of similarity or preferences (Hair, et.al, 2009). The following algorithms to perform a multidimensional scaling analysis, the researchers perform three basic steps:

*Step 1.* Collect measures of similarity or preferences across to entire set of objects to be analyzed.

*Step 2.* Use MDS techniques to estimate the relative position of each object in multidimensional space.

*Step 3.* Identify and interpret the axes of the dimensional space in terms of Perceptual And or objective attributes.

In this similarity/dissimilarity-based approach, we need some kind of a distance measure between the brands being rated. The distance measure being input could be a simple ranking of distances between a brand and all other brands by a customer. One way to do this is to provide a customer (respondent) with cards, each containing a pair of brands written on it, and asking him to write down a number indicating the difference between the two brands on any numerical scale which can represent distance. This can be repeated for all pairs of brands being included in the research. No attributes are specified by high the customer is asked to decide on the difference.

It may be assumed that a customer would tend to include parameters such as price, quality of product, after-sales-service, delivery time, his satisfaction with promised benefits, and perceptions about corporate image and so on, but he would not specify these. He would indicate distance (or dissimilarity) in some numerical value. This distance measure or dissimilarity measure can be compiled into a matrix. Input data collected from a sample of respondents each of whom was asked to rate and preferences of top three car brands on a numerical scale.

#### 4.2 Perceptual Map for dimensionality

Multidimensional scaling defines the optimal perceptual map in number of solutions of varying dimensionality. In this connection, the objective of the next step is the selection of spatial configuration in a specific number of dimensions. Three approaches are most commonly used in multidimensional scaling and they are (i) Subjective Evaluation, Stress Measures and Index of fit. In this research paper, we used Stress Measure to identify the dimension. Kruskal's Stress most commonly used measure for determining a model's goodness of fit. It is defined as:

$$Stress = \sqrt{\frac{(d_{ij} - \hat{d}_{ij})^2}{(d_{ij} - \bar{d}_{ij})^2}}$$

Where,  $\bar{d}$  = average distance  $(\sum d_{ij} / n)$  on the map

$\hat{d}_{ij}$  = derived distance from the perceptual map

$\bar{d}_{ij}$  = original distance based on similarity judgments. The stress value is low and RSQ value is higher, the model is best fit.

### 5.0 Results and Discussion

In this section, the results of multidimensional scaling and visualize the perceptual map based on the output. In tables 1 to 6 shows that the results of multidimensional scaling program using statistical packages. Table 1 and Table 2 contain the three dimensional solution, table 3 and 4 contains the two dimensional solution, table 5 and 6 contains the one dimensional solution.

Iteration history for the three dimensional solution are given in table 1 (in squared distance). The following table S-stress formula indicates that how far off the model is from the original dissimilarity matrix, its shows that lower number of mean less stress and better model.

Table 1 Iteration Histories for the Three Dimensional Solutions (in Squared Distances)

Iteration	S-stress	Improvement
1	.09705	
2	.07710	.01995
3	.06963	.00747
4	.06451	.00512
5	.06083	.00368
6	.05825	.00258
7	.05599	.00226
8	.05395	.00204
9	.05203	.00192
10	.05049	.00154
11	.04951	.00099
Iterations stopped because S-stress improvement is less than .001000		

The results of three dimension stress and squared correlation (Regression Square) in distances RSQ values are the proportion of variance of the scaled data. In the partition (row, matrix, or entire data) which is accounted for by their corresponding distances. Stress values are Kruskal's stress formula 1. The three dimension matrix stress value is .03350 and RSQ value is .98634. If the RSQ value closer to one, the result is better and efficient model.

Table 2 Stimulus Coordinates for Customer Preferences and Brand Positioning

Stimulus Number	Stimulus Name	Dimension		
		1	2	3
1	Maruti	1.2329	-.2160	1.1900
2	Hyundai	1.5216	-.8297	-.3272
3	Ford	-1.2178	.0963	.7634
4	Price	-1.4340	.2568	-.1153
5	Perform	-.4215	.2240	-1.5643
6	Colour	1.4709	1.6065	-.3855
7	Appearance	.0833	-1.8228	-.3751

8	Comfort	-1.2354	.6849	.8141
---	---------	---------	-------	-------

The results of three dimension stress and squared correlation (Regression Square) in distances RSQ values are the proportion of variance of the scaled data. In the partition (row, matrix, or entire data) which is accounted for by their corresponding distances. Stress values are Kruskal's stress formula 1. The three dimension matrix stress value is .1379 and RSQ value is .87232. If the RSQ value closer to one, the result is better and efficient model.

Table 3 Iteration History for the Two Dimensional Solution (in Squared Distances)

Iteration	S-stress	Improvement
1	.26877	
2	.23335	.03542
3	.21765	.01570
4	.19912	.01854
5	.18705	.01206
6	.18067	.00638
7	.17693	.00374
8	.17412	.00281
9	.17161	.00250
10	.16967	.00194
11	.16851	.00115
12	.16766	.00085
Iterations stopped because S-stress improvement is less than .001000		

Table 4 Stimulus Coordinates for Customer Preferences and Brand Positioning

Stimulus Number	Stimulus Name	Dimensions	
		1	2
1	Maruti	1.2329	-.2160
2	Hyundai	1.5216	-.8297
3	Ford	-1.2178	.0963
4	Price	-1.4340	.2568
5	Perform	-.4215	.2240
6	Colour	1.4709	1.6065
7	Appearance	.0833	-1.8228
8	Comfort	-1.2354	.6849

The results of three dimension stress and squared correlation (Regression Square) in distances RSQ values are the proportion of variance of the scaled data. In the partition (row, matrix, or entire data) which is accounted for by their corresponding distances. Stress values are Kruskal's stress formula 1. The three dimension matrix stress value is .331110 and RSQ value is .70581. If the RSQ value closer to one, the result is better and efficient model.

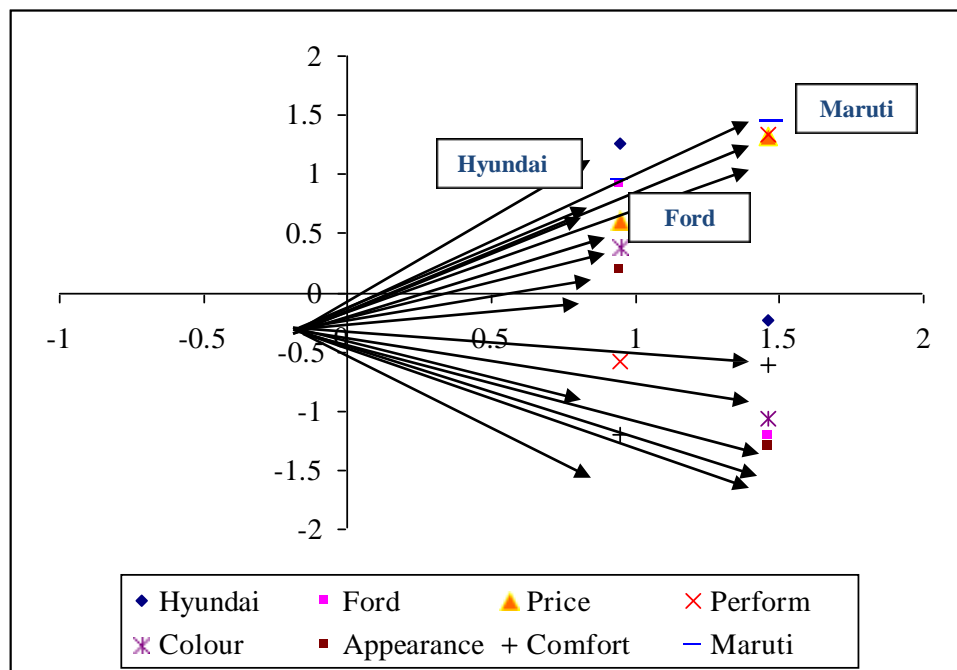
Table 5 Iteration History for the One Dimensional Solution (in Squared Distances)

Iteration	S-stress	Improvement
1	.39270	
2	.37430	.01840
3	.37279	.00151
4	.37267	.00012
Iterations stopped because S-stress improvement is less than .001000		

Table 6 Stimulus Coordinates for Customer Preferences and Brand Positioning

Stimulus Number	Stimulus Name	Dimension
1	Maruti	-1.3781
2	Hyundai	-.0119
3	Ford	1.1046
4	Price	=1.1686
5	Perform	-1.1221
6	Colour	.7844
7	Appearance	1.0276
8	Comfort	.7643

Fig 1. Perceptual Map for Customer Preferences of three Car Brands and Vector Model of Subjective Attributes



Our first task is to determine the number of dimensions in which we feel the best solution exists. The decision is based on the stress value for various solutions in different dimension. From Table 1, Table 3 and 5, we see the following values of stress.

Three dimensional solution	: 0.03350
Two dimensional solution	: 0.13797
One dimensional solution	: 0.31110

Clearly indicate that the one dimensional solution is not a good one. Remember, that the stress value indicates lack of fit, so it should be as close to zero as possible. The two dimensional solution is better, but the three dimensional solution looks the best, as the stress value is a low less than 0.05 (0.03350).

Since we have compared only top three brands of car, it is not possible to get a solution in four or more dimensions in this particular case. For example, if we had compared 12-15 brands, it would have been possible to get a solution in higher number of dimensions. But even there, ease of interpretation may require a tradeoff between stress value and number of dimensions. We may choose a slightly lower number of dimensions, in the interest of ease of interpretation or for stinginess, instead of looking only at the lowest stress value, in exceptional cases.

### 5.1 Multidimensional Scaling for three car brands

Finally, we have decided to use the three dimensional solution for interpretation in this case, the next task now would be to *name* the dimensions. For doing so, our previous knowledge of the car brands may become important. We have three brands of car, and then we must look at the qualities of various attributes offered by these brands either through our judgment or knowledge of the market or through a survey of customer preferences, or a combination of these methods. This process of interpretation tends to be subjective, regardless of the methods used. We would look at the result of multidimensional scaling, and the scores for the three brands on the two dimensions, and decided on the following names for the two dimensions.

First Dimensions: Current Brand Image  
Second Dimension: Cost for money

We could then look at the scores on the two dimensions and conclude that Maruti got the first position based on their price and performance, currently a good *brand image*, but brands like Hyundai and Ford have got the positions second and third respectively, these two brands lead in *cost for money* perceptions. If we are to choose the two dimensional solution instead of the three dimensional one, it could be visualized on perceptual map and would be visually easier to interpret. The map of the two dimensional solution shown in Fig. 1 and the brands can be seen to form distinct clusters based on their perceived similarity.

## 6 Conclusion

Multidimensional scaling establishes that the result of their scores on the two dimensions and conclude that Maruti got the first position based on their price and performance, currently a good *brand image*, but brands like Hyundai and Ford have takes the positions second and third respectively, these two brand leads in *cost for money* perceptions. The perceptual map shows that, Brands Hyundai and Ford posses to similar results, where as Maruti is a standalone brand.

## Reference

- 1) Dik W. Twedt, Ed., 1983, Survey of Marketing Research, Chicago, American Marketing Association.
- 2) Hair, et.al, 2009, Multivariate Data Analysis, Pearson Education, India
- 3) Rajendra Nargundakar (2003), **Marketing Research Text and Cases**, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- 4) Roskarn 1981, The method of trails for non-parametric multidimensional scaling, Netherlands, Vol.4, pp 204-417.
- 5) Steffle, V. J. 1972. Some applications of multidimensional scaling to social science problems. In Romney, A. K., R. N. Shepard, and S. B. Nerlove (editors), Multidimensional scaling. Seminar Press, N.Y. 1971.

\*\*\*\*\*