Chapter 14
Multidimensional Scaling for Product Positioning

Learning Objectives

After completing this chapter, you should be able to do the following:

- Know the use of multidimensional scaling in market research.
- Understand the different terms used in multidimensional scaling.
- Learn the procedures used in multidimensional scaling.
- Able to identify the research situations where multidimensional scaling can be used.
- Describe the SPSS procedure involved in multidimensional scaling.
- Explain the various outputs generated by the SPSS in this analysis.

Introduction

Multidimensional scaling (MDS) is a series of statistical techniques used for identifying the key dimensions underlying respondents' evaluations of objects and keeping them in multidimensional space. MDS is widely used in marketing research for positioning of brands. It would be desired for any company to know as to how its brand of products is rated among other similar competing brands. While assessing the brand image of any product, the respondents may rate it on the basis of its overall image or on the basis of certain attributes. Thus, besides knowing the relative positioning of the products, one may like to know the strength of the product in comparison to other similar products on different dimensions. The MDS can be used to solve varieties of problems in management research. For example, it finds application in market segmentation, product life cycle, vendor evaluation, and advertising media selection.

Though it is possible to use MDS with quantitative variables (i.e., on the basis of price, aesthetics, color, size, shape, weight, etc.), but it is mostly used to compare objects in a situation where the bases of comparison are not known. This approach of the MDS is a philosophical perspective because every person experiences the

J.P. Verma, *Data Analysis in Management with SPSS Software*,
DOI 10.1007/978-81-322-0786-3_14, © Springer India 2013

world in their own way. From this perspective, MDS procedure based on the predefined attributes is not completely satisfactory as it fails to take the individual experience into account. One way to overcome this problem is to look at the constructs an individual use to construe the world. Since the MDS is often used to identify key dimensions underlying customer evaluations of products, services, or companies, therefore once the data is at hand, multidimensional scaling can help determine the following:

- While evaluating the objects, what dimensions are used by the respondents?
- The relative importance of each dimension.
- How the objects are placed in the perceptual map.

Thus, by using the multidimensional scaling methods, one can analyze their current level of consumer satisfaction in the market and modify the marketing mix based upon the current consumer preference and satisfaction.

What Is Multidimensional Scaling

Multidimensional scaling is a sequence of techniques for exploring similarities or preferences among objects. These objects can be products, organizations, brands, outlets, etc. In this technique, similarities or preferences of objects are measured on some dimensions, and accordingly the objects are positioned in the multidimensional space for understanding the brand positioning. Through multidimensional technique, a researcher can get an idea about the respondent's perceived relative image of a set of objects. The multidimensional scaling is also known as perceptual mapping. In this technique, we transform consumer judgments of overall similarity or preferences into distances represented in multidimensional space.

Terminologies Used in Multidimensional Scaling

Objects and Subjects

In multidimensional scaling, the object refers to the products, organizations, opinions, or other choices to be compared and positioned in multidimensional space. The objects are also known as variables or stimuli. On the other hand, the subject refers to the respondents who rate the objects in multidimensional scaling. The subjects are the one who are picked up in the sample for conducting the research study. Sometimes the subjects are termed as the "source," and the objects are termed as "target."

Distances

Distance refers to the difference in the two objects on any one or more dimension as perceived by a respondent. It is the fundamental measurement concept in MDS. Distance may also be referred as similarity, preferences, dissimilarity, or proximity. There exist many alternative distance measures, but all are functions of dissimilarity/similarity or preference judgments.

Similarity vs. Dissimilarity Matrices

If the cells of matrix represent the degree of similarity between pairs represented by the rows and columns of the matrix, then the matrix is said to be similarity matrix. On the other hand, if cells of the matrix represent the extent to which one object is preferred over other in the pair, then the matrix is said to be dissimilarity matrix. Larger cell values represent greater distance. The algorithm used by SPSS in multidimensional scaling is more efficient with dissimilarity/preference measures than with similarity/proximity measures. For this reason, distance matrices are used in SPSS instead of similarity matrices.

Stress

Stress (phi) is a goodness-of-fit test that measures the efficiency of the MDS models. The smaller the stress, the better is the fit. Stress measures the difference between interpoint distances in computed MDS space and the corresponding actual input distances. High stress indicates measurement error, and also it may reflect having too few dimensions. Stress is not much affected by sample size provided the number of objects is appreciably more than the number of dimensions.

Perceptual Mapping

Perceptual mapping is a graphical representation of objects in multidimensional space. In perceptual map, points are shown for both, that is, column as well as row objects. In obtaining the perceptual map, the consumer's views about a product are plotted on a chart. Respondents are asked to give their preferences by showing each of the pair of the objects by asking about their experience with the product in terms of its performance, packaging, price, size, etc. These qualitative responses are shown on a chart (called a perceptual map) using a suitable scale (such as the Likert scale). The results of the perceptual mapping are used in improving the product or developing a new product.

Dimensions

While preparing dissimilarity matrix, the respondent may be asked to rate the two objects/products on a particular characteristics such as color, look, energy efficiency, and cost. These characteristics are said to be the dimension on which the evaluation may take place. Usually the products are rated on two or more than two dimensions. These dimensions may be predefined or may be perceived by the respondents of their own.

What We Do in Multidimensional Scaling?

The multidimensional scaling technique can be applied by either using dissimilarity-based approach or attribute-based approach. The methodologies adopted in these two approaches shall be discussed in detail below. However, solved example shall be discussed only for dissimilarity-based approach of multidimensional scaling. The detail working of this approach with SPSS has been shown in Example 14.1.

Procedure of Dissimilarity-Based Approach of Multidimensional Scaling

The dissimilarity-based approach is very simple to understand and is very useful in understanding the consumer behavior. In this approach, the respondents are asked to rate different pairs of comparable objects on the basis of their experience. While evaluating the pair of objects, the dissimilarity measure is noted on the basis of some of the parameters that the respondents have in their mind. No predefined attributes or objective criteria are given on the basis of which the respondent can evaluate the two objects in the pair. Following steps are adopted in this approach:

Steps in Dissimilarity-Based Approach

1. Find the distance matrix among all the objects. It can be obtained by simply ranking of distances between an object and all other objects by a consumer. This matrix can be obtained by providing the consumer a card containing pair of objects written on it, and the candidate needs to specify a number indicating the difference between the two objects on any numerical scale which can represent distance between the two objects. This process is repeated for all pairs of brands being included in the study. In this process, no attributes are identified on which the consumer is asked to decide on the difference. The distance measure so

Table 14.1 Matrix of dissimilarity scores

	Alto	Estilo	Wagon R	Swift	Santro	I-1o	Ford Figo	Tata Indica
Alto	0	1	3	7	4	2	4	1
Estilo	1	0	4	5	6	1	1	5
Wagon R	3	4	0	2	1	5	6	7
Swift	7	5	2	0	1	5	7	6
Santro	4	6	1	1	0	4	5	4
I-10	2	1	5	5	4	0	1	6
Ford Figo	4	1	6	7	5	1	0	3
Tata Indica	1	5	7	6	4	6	3	0

obtained for all the pair of objects can be compiled into a matrix as shown in Table 14.1. This distance matrix serves the input data for the multidimensional scaling.

2. After obtaining the distance matrix for each consumer, take the average of these distances for each pair of objects to make the final distance matrix which is normally used as an input data. However, multidimensional scaling can be used for a single user as well.
3. Compute the value of "stress" for the solution in each dimension. Since the value of stress represents a measure of lack of fit, therefore the intension is to get the solution with an acceptably low value of a stress.
4. On the basis of the least value of the stress obtained in different solutions, obtained in step 3, the number of dimensions is decided.
5. After deciding the number of dimensions, the objects are plotted on a map for visual assessment of objects positioning.
6. Name these dimensions by keeping in mind the attributes of the brands like cost, features, and look. The procedure would be clear by looking to the solved Example 14.1.

Procedure of Attribute-Based Approach of Multidimensional Scaling

In attribute-based approach, the respondents are required to assess each pair of objects on the basis of the predefined criteria (i.e., color, weight, look, features, cost, etc.). In this method, perceptual map of the objects is developed using discriminant analysis. This perceptual map can be developed using the factor analysis as well. However, there is a debate as to which method produces better perceptual maps. In this chapter, we shall discuss only discriminant analysis method for developing perceptual map. In Chap. 12, we have discussed the procedure of discriminant analysis in detail for categorizing the customer into two groups (issuing/not issuing the credit cards). In MDS, we may have as many groups as there are objects/brands. Thus, in this case, mostly we will get more than one

discriminant function. For example, in case of three objects/brands, you could get two functions, and with four objects, you may get up to three discriminant functions. The solution of discriminant analysis gives the value of eigenvalue for each discriminant function. This eigenvalue explains the amount of variance that is explained by the discriminant function. This percentage variance explained by the discriminant function is used to decide as to how many discriminant functions one should use. If two discriminant functions are used, then they form two axes of the perceptual map. Whereas if three discriminant functions are used, then you get three perceptual maps, that is, function 1 vs. function 2, function 1 vs. function 3, and function 2 vs. function 3. These discriminant functions represent the axes on which the objects are first located and thereafter the attributes are located.

To find the number of dimensions and the perceptual map of different objects, following steps are used:

1. Obtain consumers' perceptions on different attributes on the different competing brands. This serves as the input data for the discriminant analysis.
2. Run the discriminant analysis by taking all the independent variables together in the model. The option for this method can be seen in SPSS as "Enter independents together."
3. The SPSS output shall generate the following results:

   (a) Group statistics including mean and standard deviation
   (b) Unstandardized canonical discriminant function coefficients table
   (c) Eigen values and canonical correlation
   (d) Wilks' lambda and chi-square test
   (e) Classification matrix
   (f) Standardized canonical discriminant function coefficients
   (g) Functions at group centroids

   Remark: For generating the above-mentioned outputs for MDS, you can refer back the solved Example 12.1 in Chap. 12.

4. The eigenvalue would decide as to how many discriminant function you want to use.
5. Draw perceptual map (or maps) separately by using the standardized canonical discriminant coefficients. This can be done by using Excel or any other graphic package. The discriminant function denotes the axes on which the objects/brands are first located, and then attributes are placed on the same graph.

Assumptions in Multidimensional Scaling

Following assumptions are made while performing the multidimensional scaling:

1. All respondents will rate the objects on the same dimensions.
2. Dimensions are orthogonal.

3. The respondents have the same perception about the dimensionality in assessing the distances among the objects.
4. Respondents will attach the same level of importance to a dimension, even if all respondents perceive this dimension.
5. There is no change in the judgments of a stimulus in terms of either dimensions or levels of importance over time.

Limitations of Multidimensional Scaling

Although MDS is widely used for positioning the brand image and comparing the product characteristics, it has some limitations as well.

1. It is difficult to obtain the similarity and preferences of the respondents toward a group of objects because perceptions of the subjects may differ considerably.
2. Because every product has lots of variant model having different characteristics and therefore the group of objects taken for comparing their brand image may itself differ on many counts. Due to this fact, true positioning may not be possible.
3. Preferences change over time, place, and socioeconomic status and therefore brand positioning obtained in a particular study may not be generalized.
4. The bias exists in the data collection.
5. In case of nonmetric data, all the MDS techniques are subject to the problem of local optima and degenerate solutions.
6. Although metric MDS are more robust than nonmetric MDS and produce good maps but the dimension interpretation, the main work of MDS is highly subjective and depends upon the questioning of the interviewers.

Solved Example of Multidimensional Scaling (Dissimilarity-Based Approach of Multidimensional Scaling) Using SPSS

Example 14.1 Twenty customers were asked to rate 8 cars by showing the cards bearing the name of a pair of cars. All possible pair of cars were shown, and the customers were asked to rate their preferences of one car over other on an 8-point scale. If the customer perceived that the two cars were completely dissimilar, a score of 8 was given, and if the two cars were exactly similar, a score of 0 was given. Following dissimilarity scores were obtained and are shown in Table 14.1. Use multidimensional scaling to find the number of dimensions the consumers use in assessing different brands and name these dimensions. Develop perceptual map and position these eight brands of cars in a multidimensional space.

Solution In order to find the number of dimensions used by the consumers in assessing these eight brands of car, the multidimensional scaling option of SPSS shall be used to generate outputs showing stress value for the solutions of different dimensions. Simultaneously dimensions for stimulus coordinates in different solutions shall also be obtained which shall be used to place all the eight brands of cars in the multidimensional map.

SPSS Commands for Multidimensional Scaling

The data file needs to be prepared before using SPSS commands to generate outputs in multidimensional scaling. Following steps would be performed to get the relevant outputs for further interpretation in the analysis.

(i) *Data file*: Here, eight variables need to be defined. All these variables shall be defined as ordinal as the scores are the dissimilarity ratings. After preparing the data file by defining variable names and their labels, it will look like Fig. 14.1.

(ii) *Initiating command for multidimensional analysis*: After preparing the data file, click the following command sequence in the Data View:
Analyze → Scale → Multidimensional Scaling (ALSCAL)
The screen shall look like Fig. 14.2.

(iii) *Selecting variables for discriminant analysis*: After clicking the **Multidimensional Scaling** option, the SPSS will take you to the window where variables are selected.

- Select all the variables from left panel to the "Variables" section of the right panel.
- Click the tag **Model** in the screen shown in Fig. 14.3.
  - Write minimum and maximum dimension for which the solution is required. Since, in this problem, there are eight brands, hence maximum of up to three-dimensional solution shall be obtained. In case of more number of brands, solutions of more dimensions may be investigated.
  - Let other options are checked by default.
  - Click ***Continue***.
- Click the tag **Option** in the screen as shown in screen 14.3.
  - Check the option "Group plots" in the Display section.
  - Let other options are checked by default.
  - Click ***Continue.***

  The screen for these options shall look like Fig. 14.4.
  - Click **OK** for output.

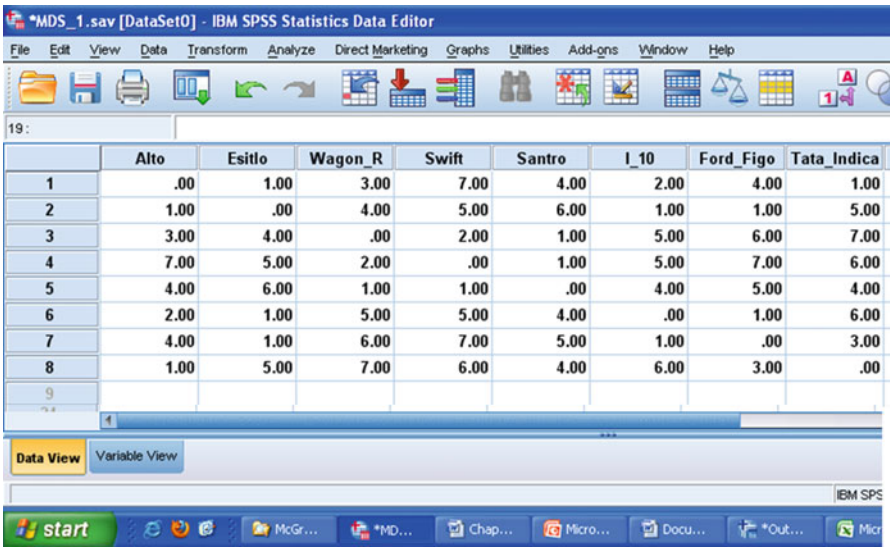

Fig. 14.1 Screen showing data file for the multidimensional scaling in SPSS

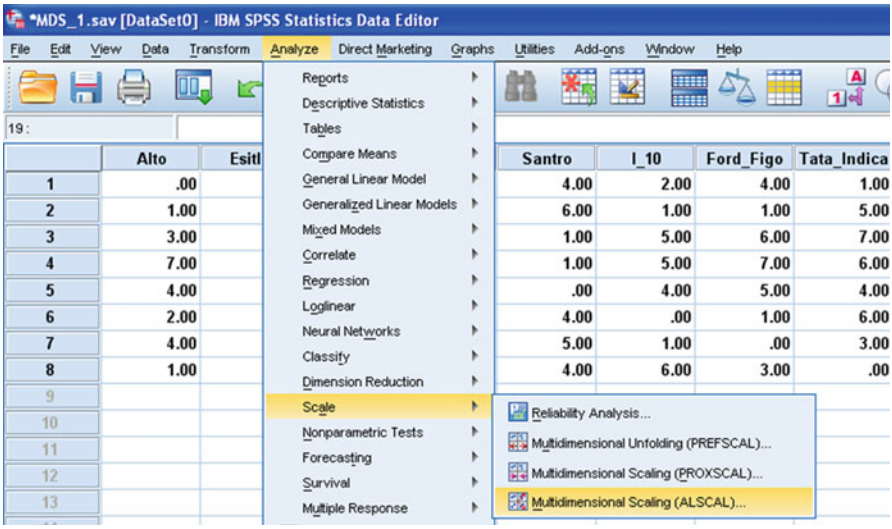

Fig. 14.2 Screen showing SPSS commands for multidimensional scaling

(iv) *Getting the output*: After clicking the **OK** option in Fig. 14.3, the output in the multidimensional scaling shall be generated in the output window. Selected outputs can be copied in the word file by using the right click of the mouse over identified area of the output. Out of many outputs generated by the SPSS, the following relevant outputs have been picked up for discussion:

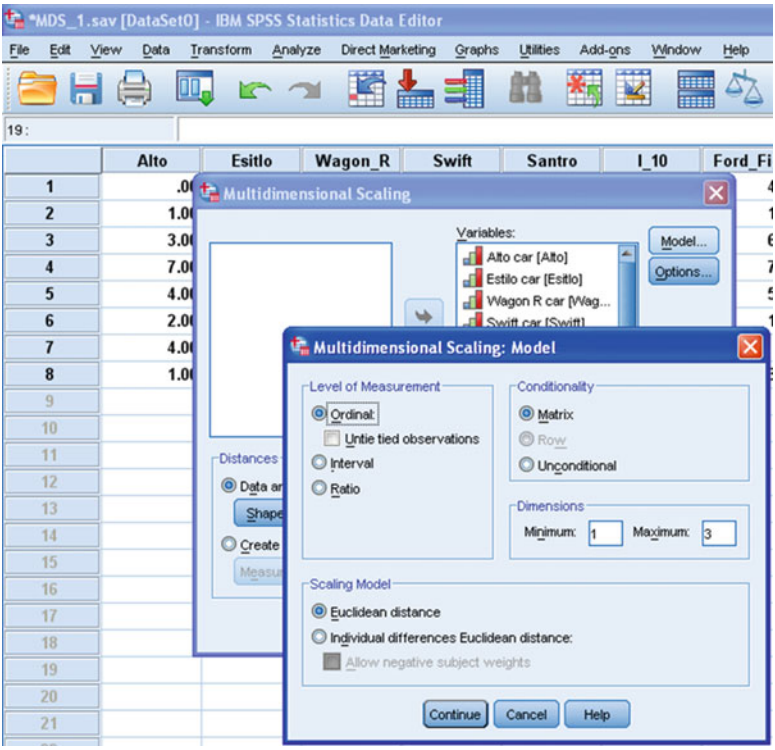

Fig. 14.3 Screen showing selection of variables and dimensions

1. Iteration details for the three-dimensional solution, stress value of the matrix, and stimulus coordinates (Tables 14.2 and 14.3)
2. Iteration details for the two-dimensional solution, stress value of the matrix, and stimulus coordinates (Tables 14.4 and 14.5)
3. Iteration details for the one-dimensional solution, stress value of the matrix, and stimulus coordinates (Tables 14.6 and 14.7)
4. Perceptual map of all the eight brands (Fig. 14.5)

These outputs so generated by the SPSS are shown in Tables 14.2, 14.3, 14.4, 14.5, 14.6, and 14.7 and Fig. 14.5.

Interpretation of Various Outputs Generated in Multidimensional Scaling

From these outputs, it is required to determine the number of dimensions in which you feel the best solution exists. This decision is based upon the stress value for the solutions in different dimensions. Tables 14.2 and 14.3 show the three-dimensional

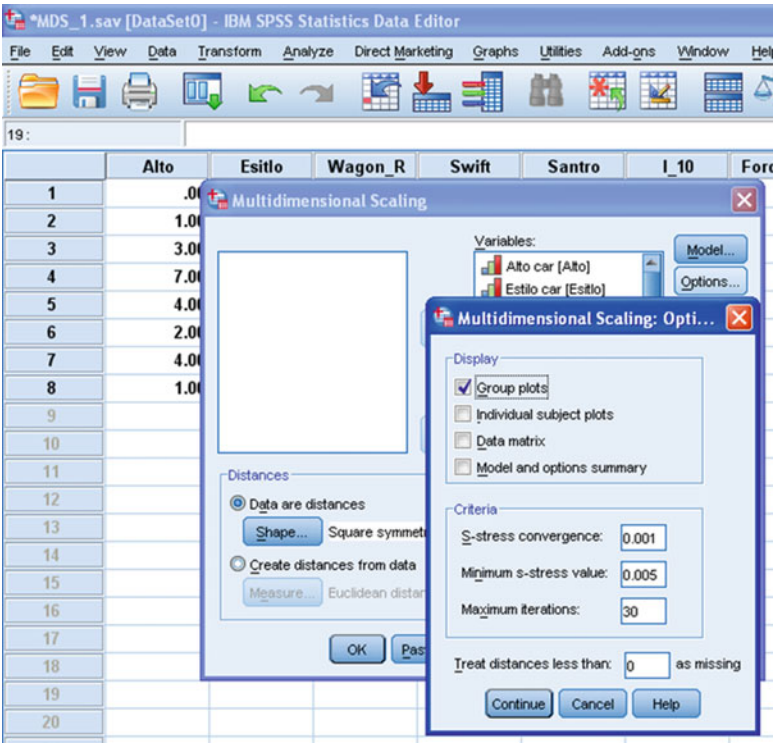

Fig. 14.4 Screen showing the options for perceptual mapping

solution, and the stress value for these solutions is 0.07911. Tables 14.4 and 14.5 contain two-dimensional solutions along with the stress value as 0.16611. On the other hand, the one-dimensional solutions are shown in Tables 14.6 and 14.7 along with the stress value 0.42024.

Stress value shows the lack of fit, and therefore, it should be as close to zero as possible. Owing to these criteria, the one-dimensional solution is not good at all as this contains the maximum value of stress (0.42024). The two-dimensional solution looks better as it is close to zero, but the three-dimensional solution is the best because its stress value is the least.

Since in this problem there are only eight brands, therefore it is not possible to get a solution in more than three dimensions. If you have more than 14 or 15 brands, you may try some higher dimension solution. To find out the optimum solution, one needs to have the trade-off between stress value and the number of dimensions.

Three-Dimensional Solution

Based on the stress value, the three-dimensional solution is the best as in that case the stress value is the least and closest to zero. Therefore, the next task is to define

the names of these three dimensions. These dimensions are the attributes of these brands drawn either through our experience or knowledge of the market through a survey of the customers or a combination of these methods. Thus, the three dimensions may be named as follows:

Dimension 1: Spacious
Dimension 2: Fuel economy
Dimension 3: Stylish

By looking to the scores on the three dimensions in Table 14.3, it may be concluded that the brands like Wagon R, Swift, and Santro are spacious than other brands of similar cars. Brands like Tata Indica and Alto are fuel economical cars, whereas the brands like Ford Figo and Swift are more stylish cars.

Table 14.2 Iteration details for the three-dimensional solution Young's S-stress formula 1 is used

Iteration	S-stress	Improvement
1	.14535	
2	.12004	.02531
3	.11372	.00632
4	.11188	.00184
5	.11126	.00062

Iterations stopped because
S-stress improvement is <.001000
Stress and squared correlation (RSQ) in distances RSQ values are the proportion of variance of the scaled data (disparities) in the partition (row, matrix, or entire data) which is accounted for by their corresponding distances. Stress values are Kruskal's stress formula 1.
For matrix,
Stress = .07911 RSQ = .92211
Configuration derived in three dimensions

Table 14.3 Stimulus coordinates

		Dimension		
Stimulus number	Stimulus name	1	2	3
1	Alto	.8774	.6086	−.9932
2	Estilo	.9917	−1.0586	−.4867
3	Wagon_R	−1.3459	−.1183	−1.2193
4	Swift	−1.8536	−.0029	.8010
5	Santro	−1.4590	.6055	.2352
6	I_10	.6751	−1.3468	.4928
7	Ford_Figo	1.2702	−.5423	.9944
8	Tata_Indica	.8441	1.8548	.1759

Two-Dimensional Solution

For the sake of understanding, the perceptual map shall be discussed for two-dimensional solutions. If two-dimensional solutions would have been preferred instead of three-dimensional solutions, then the perceptual map would be shown by Fig. 14.5. Looking to this figure, the brands like Swift, Santro, and Wagon R are perceived to be similar (spacious). Similarly the brands like Tata Indica and Alto are perceived to be similar (fuel economy). In this case, we are losing information on the third dimension which was "stylishness" in the three-dimensional solution. This loss of information may be critical in some cases. It is therefore advisable to analyze the data from a three-dimensional solution instead of a two-dimensional, provided stress value warrants so.

Table 14.4 Iteration details for the two-dimensional solution Young's S-stress formula 1 is used

Iteration	S-stress	Improvement
1	.22053	
2	.19234	.02820
3	.17623	.01611
4	.16411	.01211
5	.15461	.00950
6	.14791	.00670
7	.14367	.00424
8	.14159	.00208
9	.14139	.00020

Iterations stopped because
S-stress improvement is <.001000
Stress and squared correlation (RSQ) in distances RSQ values are the proportion of variance of the scaled data (disparities) in the partition (row, matrix, or entire data) which is accounted for by their corresponding distances. Stress values are Kruskal's stress formula 1.
For matrix,
Stress = .16611 RSQ = .87594
Configuration derived in two dimensions

Table 14.5 Stimulus coordinates

		Dimension	
Stimulus number	Stimulus name	1	2
1	Alto	1.0933	.7542
2	Estilo	.9651	−.7312
3	Wagon_R	−1.4408	.1261
4	Swift	−1.4492	.2257
5	Santro	−1.4133	.2052
6	I_10	.9121	−.8085
7	Ford_Figo	.6121	−1.3142
8	Tata_Indica	.7206	1.5429

Table 14.6 Iteration details for the one-dimensional solution Young's S-stress formula 1 is used

Iteration	S-stress	Improvement
1	.44444	
2	.43243	.01201
3	.43185	.00057

Iterations stopped because
S-stress improvement is <.001000
Stress and squared correlation (RSQ) in distances RSQ values are the proportion of variance of the scaled data (disparities) in the partition (row, matrix, or entire data) which is accounted for by their corresponding distances. Stress values are Kruskal's stress formula 1.
For matrix,
Stress = .42024 RSQ = .57334
Configuration derived in one dimension

Table 14.7 Stimulus coordinates

		Dimension
Stimulus number	Stimulus name	1
1	Alto	−.8034
2	Estilo	−.7738
3	Wagon_R	1.2367
4	Swift	1.4484
5	Santro	1.1694
6	I_10	−.6166
7	Ford_Figo	−.8593
8	Tata_Indica	−.8015

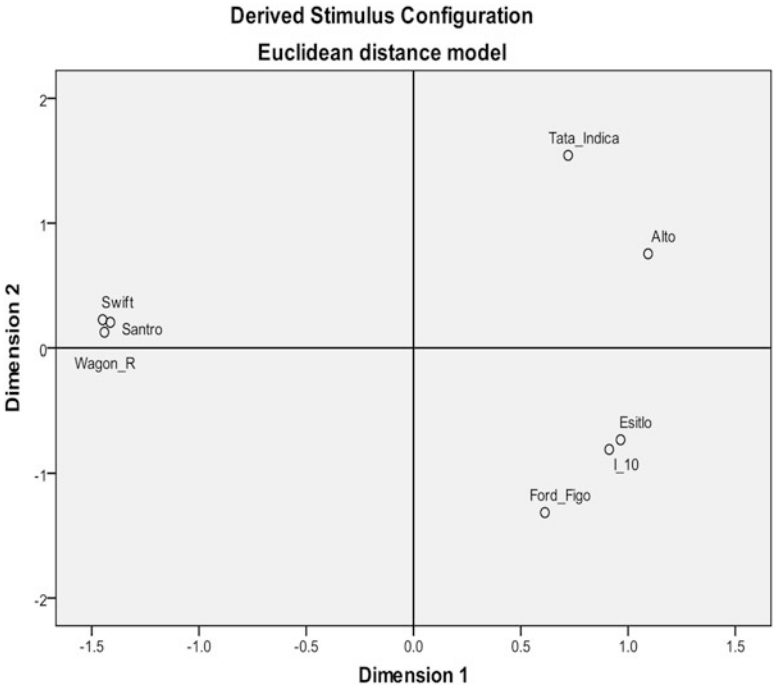

Fig. 14.5 Perceptual map of different brands of car (two-dimensional output)

Summary of the SPSS Commands for Multidimensional Scaling

(i) Start SPSS and prepare the data file by defining the variables and their properties in **Variable View** and typing the data column wise in Data View.
(ii) In the data view, follow the below-mentioned command sequence for multidimensional scaling:
Analyze → Scale → Multidimensional Scaling (ALSCAL)
(iii) Select all the variables from left panel to the "Variables" section of the right panel.
(iv) Click the tag **Model** and write minimum and maximum dimension for which the solution is required. Let other options are checked by default. Click ***Continue***.
(v) Click the tag **Option** in the screen and check the option "Group plots" in the Display section. Let other options are checked by default. Click ***Continue.*** Click **OK** for output.

Exercise

Short Answer Questions

Note: Write answer to each of the following questions in not more than 200 words.

1. Define multidimensional scaling and explain a situation in marketing where this technique can be used.
2. Discuss the procedure used in dissimilarity-based approach of multidimensional scaling.
3. What are the steps used in attribute-based approach of multidimensional scaling?
4. What are the drawbacks of multidimensional scaling?
5. Explain the assumptions used in multidimensional scaling.
6. Describe any five terminologies used in multidimensional scaling.
7. What do you mean by stress score? What is its significance and how is it used in deciding the solution in multidimensional scaling?
8. What are the various considerations in deciding the name of the dimensions?
9. What do you mean by a perceptual map? Explain by means of an example.
10. Explain the difference in attribute-based approach and dissimilarity-based approach of multidimensional scaling.

Multiple-Choice Questions

Note: Question no. 1–10 has four alternative answers for each question. Tick mark the one that you consider the closest to the correct answer.

1. MDS refers to

   (a) Multidimensional spaces
   (b) Multidirectional spaces
   (c) Multidimensional perceptual scaling
   (d) Multidimensional scaling

2. Stress is a measure of

   (a) Distance between the two brands
   (b) Goodness of fit
   (c) Correctness of the perceptual map
   (d) Error involved in deciding the nomenclature of dimensions

3. Perceptual mapping is a

   (a) Graphical representation of the dimensions in multidimensional space
   (b) Graphical representation of objects in multidimensional space
   (c) Graphical representation of the distances of the objects
   (d) Graphical representation of brands in two-dimensional space

4. Dimensions refer to

   (a) The brands on which clustering is made
   (b) The characteristics of the brands which are clubbed for assessment
   (c) The brands which have some attributes common in them
   (d) The characteristics on which the evaluation may take place

5. In dissimilarity-based approach of multidimensional scaling, the input data are

   (a) Nominal
   (b) Ordinal
   (c) Scale
   (d) Ratio

6. The solution of multidimensional is accurate if the value of stress is

   (a) Less than 1
   (b) More than 1
   (c) Closer to 0
   (d) Closer to 0.5

7. In attribute-based approach of multidimensional scaling, the input data can be

   (a) Interval
   (b) Nominal
   (c) Ordinal
   (d) None of the above

8. One of the assumptions in multidimensional scaling is

   (a) The respondents will not rate the objects on the same dimensions.
   (b) Dimensions are orthogonal.

(c) Respondents will not attach the same level of importance to a dimension, even if all respondents perceive this dimension.
(d) Data are nominal.

9. Choose the correct sequence of commands in SPSS for multidimensional scaling.

(a) Analyze → Scale → Multidimensional Scaling (ALSCAL)
(b) Analyze → Multidimensional Scaling (ALSCAL) → Scale
(c) Analyze → Scale → Multidimensional Scaling (PROXSCAL)
(d) Analyze → Multidimensional Scaling (PROXSCAL) → Scale

10. Following solutions are obtained in the multidimensional scaling:

(i) One-Dimensional Solution with Stress score = 0.7659
(ii) Two-Dimensional Solution with Stress score = 0.4328
(iii) Three-Dimensional Solution with Stress score = 0.1348
(iv) Four-Dimensional Solution with Stress score = 0.0924

Which solution would you prefer?

(a) ii
(b) i
(c) iv
(d) iii

Assignments

1. A refrigerator company wanted to draw a perceptual map using its consumers' perceptions regarding its own brand and five competing brands. These six brands were Samsung, LG, Videocon, Godrej, Sharp, and Hitachi. The customers were shown a card containing a pair of names of these brands and were asked to rate in terms of dissimilarity between the two on an 8-point rating scale. The rating of 8 indicates that the two brands are distinctively apart, whereas 1 indicates that the two brands are exactly similar as perceived by the customers. This exercise was done on all the pair of brands. The average dissimilarity ratings obtained by all the customers are shown in the following table. Apply the multidimensional scaling and interpret your findings by plotting the perceptual map of these brands.

Dissimilarity ratings obtained by the customers on the six brands of the refrigerators

	Samsung	LG	Videocon	Godrej	Sharp	Hitachi
Samsung	0	4	3	7	4	3
LG		0	3	8	3	2
Videocon			0	7	3	5
Godrej				0	6	8
Sharp					0	4
Hitachi						0

2. The authorities in a university wanted to assess its teachers as perceived by their students on a seven-point scale by drawing the perceptual map. Six teachers,

Smith, Anderson, Clark, Wright, Mitchell and Johnson were rated by 25 students. Score 7 indicated that the two teachers were distinctively apart, whereas the score 1 represented that they were exactly similar as perceived by the students. Following is the dissimilarity matrix obtained on the basis of the average dissimilarity scores obtained on all the 25 students. By using the multidimensional scaling technique, draw the perceptual map.

Dissimilarity ratings obtained by the students on the teachers in the college

	Smith	Anderson	Clark	Wright	Mitchell	Johnson
Smith	0	4	3	1	5	6
Anderson		3	2	5	3	2
Clark			0	4	3	4
Wright				0	6	5
Mitchell					0	4
Johnson						0

Answers of Multiple-Choice Questions

Q.1 d	Q.2 b	Q.3 b	Q.4 d
Q.5 b	Q.6 c	Q.7 a	Q.8 b
Q.9 a	Q.10 d		