# 9. Consumer behaviour analysis: A practical approach

**V. Geethalakshmi**
Extension, Information & Statistics Division
ICAR-Central Institute of Fisheries Technology, Cochin-682029, India
geethasankar@gmail.com

In a business, understanding consumer behaviour plays an important role in success. To be in a business for a long time, it is essential to know what the consumer prefers and why. Consumers make the buying decisions based on a number of factors. The purpose behind studying the buying behaviour and consumer preference is to produce and market products which may better meet the needs of a consumer. The emerging fast-food culture among the young and affordable has brought focus on processed food and its demand in the domestic food market in India.

Several efforts are being made on the research front for development of novel products from fish which have enhanced shelf life, retain the freshness and nutrients and are safe to consume. During the course of product development, which are in many stages, studies are conducted prior to commercialisation to ensure the acceptance of a product. Domestically, spending on food and food products constitutes the largest portion of the Indian consumer's spending – more than a 31% share of wallet. Evaluation of consumer preferences before introducing a new product will help the marketer to refine the product for better reach.

**Conjoint analysis**

Conjoint analysis is a popular technique used in marketing research to study the features a product should possess to have a wide consumer reach. Conjoint analysis was initially conceptualised by Luce and Tukey (1964) and further developed by Green and Rao (1971) for marketing research. It employs a decompositional method to estimate the structure of consumer preferences and consumer utility values of different attributes of a product or service. It is a decompositional method that disaggregates the structure of consumer preferences into utility values. The relative importance of a product can also be estimated using this method.

Products possess attributes such as price, color, ingredients, guarantee, environmental impact, predicted reliability, and so on. Consumers typically do not have the option of buying the product that is best in every attribute, particularly when one of those attributes is price. Consumers are forced to make trade-offs as they decide which products to purchase. Consider the decision to purchase a car. Increased size generally means increased safety and comfort. The trade off is an increase in cost and environmental impact and a decrease in mileage and maneuverability. Conjoint analysis is used to study these trade-offs.

If products are composed of attributes, conjoint analysis determines which combination of attribute levels are most preferred by consumers. Consumers indicate their preferences by ranking a number of different combinations of attribute levels. Conjoint analysis assumes that consumers make purchases by simultaneously considering several attributes of a product. The ability to analyze several attributes at once distinguishes conjoint analysis from traditional market research methods where each attribute is studied separately. Usually, conjoint analysis consists of a main-effects analysis of variance with ordinally scaled dependent variables. Consumer preferences are the dependent variables, and product attributes are the independent variables. The following are some of the questions that can be answered with a conjoint analysis:

- How important is each product attribute to consumers?
- Which existing products do consumers prefer?
- What combination of product attributes do consumers prefer most?
- How well will my product do in the current market?

Conjoint analysis is based on a main effects analysis-of-variance model. Subjects provided at about their preferences for hypothetical products defined by attribute combinations. Conjoint analysis decomposes the judgment data into components, based on qualitative attributes of the products. A numerical part-worth utility value is computed for each level of each attribute. Large part-worth utilities areas signed to the most preferred levels, and small part-worth utilities are assigned to the least preferred levels. The attributes with the largest part-worth utility range are considered the most important in predicting preference. Conjoint analysis is a statistical model with an error term and a loss function.

Metric conjoint analysis models the judgments directly. When all of the attributes are nominal, the metric conjoint analysis is a simple main-effects ANOVA with some specialized output. The attributes are the independent variables, the judgments comprise the dependent variable, and the part-worth utilities are the β's, the parameter estimates from the ANOVA model. The following formula shows a metric conjoint analysis model for three factors:

$$y_{ijk} = \mu + \beta_{1i} + \beta_{2j} + \beta_{3k} + e_{ijk}$$

where $X\beta_{1i} = X\beta_{2j} = X\beta_{3k} = 0$

This model could be used, for example, to investigate preferences for cars that differ on three attributes: mileage, expected reliability, andprice. The $y_{ijk}$ term is one subject's stated preference for a car with the ith level of mileage, the jth level of expected reliability, and the kth level of price. The grand mean is $\mu$, and the erroris $e_{ijk}$. The predicted utility for the ijk productis:

$$\hat{y}_{ijk} = \hat{\mu} + \hat{\beta}_{1i} + \hat{\beta}_{2j} + \hat{\beta}_{3k}$$

Non metric conjoint analysis finds a monotonic transformation of the preference judgments. The model, which follows directlyfromconjointmeasurement, iterativelyfitsthe ANOVA model until the transformation stabilizes. The $R^2$increasesduringeveryiterationuntilconvergence, whenthechange in R square is essentially zero. The following formula shows a nonmetric conjoint analysis model for three factors:

$$\Phi(y_{ijk}) = \mu + \beta_{1i} + \beta_{2j} + \beta_{3k} + e_{ijk}$$

where $\Phi(yijk)$ designates a monotonictransformationofthe variable y.

The $R^2$ for a nonmetric conjoint analysis model is always greater than or equal to the $R^2$ from a metric analysis of the same data. The smaller $R^2$ in metric conjoint analysis is not necessarily a disadvantage, sinceresults shouldbemore stable and reproducible with the metric model.Metric conjoint analysis was derived from nonmetric conjoint analys is as a special case. Today, metric conjoint analysis is probably used more often than nonmetric conjoint analysis.In the SAS System, conjoint analysis is performed with the SAS/STAT procedure TRANSREG (transformation regression). Metric conjoint analysis models are fit using ordinary least squares, and nonmetric conjoint analysis models are fit using an alternating least squares algorithm (Young 1981; Gifi 1990).

**Fractional factorial design**

When the attributes of the product which is to be marketed are finalised and the levels of the attributes to be studied are fixed, the marketer will behaving many product combinations. For example,if there are 4 attributes with 3 levels each then 81 product combinations will have to be evaluated for consumer preference whichis a tedious task and during a survey the consumers will not be patient enough to spare a long time. Fractional factorial designs can be used to reduce number of product combinations which can be used for the consumer preference study.

**Practical example**

This example uses PROC TRANSREG to perform a conjoint analysis to study preferences for fish valued added products. The fish products have four attributes: three with three levels and one with two levels. The attributes are shown in the following table:

| Factor | Levels |
|---|---|
| Main Ingredient | Meat, Fish, Vegetable |
| Price | Rs.8, Rs.12, Rs.15 |
| Product form | Stuffed, Fried, Sanwich |
| Perceived quality | Yes, No |

**Generating the design**

We can use the %MktExautocall macro to find a design. When you invoke the %MktEx macro for a simple problem, you only need to specify the numbers of levels and number of runs. The %MktEx macro can create designs in a number of ways. For this problem, it simply looks up an orthogonal design. The following step invokes the %MktEx macro:

%mktex(3 3 3 2, n=18)

The first argument to the %MktEx macro is a list of factor levels, and the second is the number of runs (n=18). The %MktEx macro creates two output data sets with the experimental design, Design and Randomized. The Design data set is sorted. In the randomized design, the profiles are presented in a random order and the levels have been randomly reassigned. We use the FORMAT procedure to create descriptive labels for the levels of the attributes. By default, the values of the factors are positive integers.

**Data**

About 18 data cards are to be separately prepared and the consumers asked to sort the cards from most preferred to least preferred. The combination numbers (most preferred to least preferred) are entered as data. The data are transposed, going from one observation and 18 variables to 18 observations and one variable named Combo. The next DATA step creates the variable Rank: 1 for the first and most preferred combination, ..., and 18 for the last and least preferred combination. The following steps sort the data by combination number and merge them with the design:

```
title 'Product';
data results;
input combo1-combo18;
datalines;
17 6 8 7 10 5 4 16 15 1 11 2 9 14 12 13 3 18
;
proc transpose out=results(rename=(col1=combo)); run;
data results; set results; Rank = _n_; drop _name_; run;
proc sort; by combo; run;
data results(drop=combo);
merge sasuser.dietdes results;
run;
proc print; run;
```

You can use PROC TRANSREG to perform the nonmetric conjoint analysis of the ranks as follows:

```
proc transreg utilities order=formatted separators=', ';
model monotone(rank / reflect) =
class(Ingredient PriceFormp_quality / zero=sum);
output out=utils p ireplace;
run;
```

The utilities option displays the part-worth utilities and importance table. The order=formatted option sorts the levels of the attributes by the formatted values. By default, levels are sorted by their internal unformatted values (in this case the integers 1, 2, 3). The model statement names the variable Rank as the dependent variable and specifies a monotone transformation for the nonmetric conjoint analysis. The reflect transformation option is specified with rank data. With rank data, small values mean high preference and large values mean low preference. The reflect transformation option reflects the ranks around their mean (–(rank – mean rank) + mean rank) so that in the results, large part-worth utilities mean high preference. With ranks ranging from 1 to 18, reflect transforms 1 to 18, 2 to 17, ..., r to (19 − r), ..., and 18 to 1. The class specification names the attributes and scales the part-worth utilities to sum to zero within each attribute.

The output statement creates the out= data set, which contains the original variables, transformed variables, and indicator variables. The predicted utilities for all combinations are written to this data set by the p option (for predicted values). The ireplace option specifies that the transformed independent variables replace the original independent variables, since both are the same.

**Consumer acceptance and sensory evaluation**

Demand by the time-conscious consumer for convenience foods has increased recently required modern methods in processing, packaging, distributing and advertising. Testing consumer acceptance of a product through standard sensory evaluation methods is adopted by the food industry to determine the general acceptability and shelf life of a product. To predict the acceptability of a product sensory evaluation is carried out. Taste panel is a group of members specially constituted for sensory evaluation of food products. Desirability and other characteristics of a products will stated by the taste panel members after tasting the samples of the newly developed food product. Using a prescribed procedure called screening of the taste panel members, the persons who constitute the panel are selected carefully. Descriptive tests, preference tests, difference / discriminatory tests are the statistical methods used to study consumer acceptance.

**Descriptive tests**

By using this test, a complete description of all the product characteristics is done. This guides the product developer to modify the product to suit to the needs of the general public. A group of highly trained panelists examine a particular property of a product to provide a detailed descriptive evaluation of it. Appearance has the greatest influence on the consumer since visual appeal stimulates appetite and help to select the product at the first glance among many other brands. Taste of food is also crucial. Once the food has been tasted the flavour of the food becomes important. It ensures continued use of the product by the consumer. Therefore it is highly essential that when a new product is developed, consumer acceptance studies of these properties are conducted before promoting the product.

Profile of each characteristic is recorded such as the appearance profile, texture profile, flavour profile, etc. The flavour profile is the description of the taste and odour of the product. The description should contain the intensity of each factor, the order in which the factors are perceived, after taste and overall impression. The texture profile is the description of the textural characteristics perceived in a product, the intensity of each factor and the order in which they are perceived. Mechanical characteristics like hardness, fracturability, chewiness, gumminess, adhesiveness and viscosity and geometrical characteristics like grittiness, coarseness and fibrousness are described.

**Scaling**

The rating scale method provides the members with a scale showing several degrees of magnitude. The members' task is to assign a rating to a particular attribute such as taste, odour or texture. For each of the property to be evaluated a scale is constructed. For example if the freshness of the product is to be evaluated, use a 5-point scale such as very fresh, fresh, neutral, spoiled, very spoiled. The panel members together agree upon the scale terms to be used and evaluate the samples. The data are tabulated and analysed using analysis of variance.

**Free choice profiling**

In this technique, the members are told what attributes are to be judged. Members are presented with samples belonging to the category being examined and are instructed to use a common scale. Each panel member selects the attributes, develops a score card and rate samples accordingly.

**Repertory Grid Method**

In this method, the panel members are given two or three samples of the same product and asked to describe the similarities and differences in the samples. The information on the attributes thus collected will be analyzed to find out analogies among descriptors obtained.

**Demerit system** Various sensory factors associated with different organs of fish like skin, eyes, gills, belly, vent etc. are described and graded from 0 for extremely fresh and above for the extent of spoilage. The number of scores for each factor is given based on its contribution towards spoilage. Every description of the demerit point is very brief usually involving one or two words. No single feature is given undue importance and the fish sample is evaluated based on the totality of the sample.

**Preference tests**

Preference tests are affective tests based on a measure of preference from which relative preferences can be determined. Three popular preference tests are paired comparison, the hedonic scale and ranking tests.

**Paired comparison test**

The member is presented with a pair of samples – one will be the new product developed and another will be a sample of the existing product and asked which he prefers. The member will be instructed what attributes to judge. The two samples of the pair have to be given simultaneously or successively. The time interval between samples of pair may vary from 10 to 40 seconds. Longer intervals are used when stimuli are strong, thus probably highly adapting. When multiple pairs are presented at a session, the interval between pairs should not be less than 40 seconds. The members should rinse their mouth between tasting each sample of a pair. Analysis of data is done by applying t-test or Chi-square test. Using tables for the rapid analysis of paired comparison tests, the data is analyzed (Table 1). Suppose the sample was preferred by 16 persons in a panel of 25 members, then we conclude the product is not preferred over the other because at least 18 preferences are needed for a significant result.

**Table 1: Number of choices required for significance at various levels in a paired comparison test where either sample may be chosen. Chance probability is 50 percent and the hypothesis is two-tailed.**

| No. of judgments | Minimum Number required | | | No. of judgment | Minimum Number required | | | No. of judgment | Minimum Number required | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5% | 1% | 0.1% | | 5% | 1% | 0.1% | | 5% | 1% | 0.1% |
| 1 | …. | …. | …. | 31 | 22 | 24 | 25 | 72 | 45 | 48 | 51 |
| 2 | …. | …. | …. | 32 | 23 | 24 | 26 | 74 | 46 | 49 | 52 |
| 3 | …. | …. | …. | 33 | 23 | 25 | 27 | 76 | 48 | 50 | 53 |
| 4 | …. | …. | …. | 34 | 24 | 25 | 27 | 78 | 49 | 51 | 54 |
| 5 | …. | …. | …. | 35 | 24 | 26 | 28 | 80 | 50 | 52 | 56 |
| 6 | 6 | …. | | 36 | 25 | 27 | 29 | 82 | 51 | 54 | 57 |
| 7 | 7 | …. | …. | 37 | 25 | 27 | 29 | 84 | 52 | 55 | 58 |
| 8 | 8 | 8 | …. | 38 | 26 | 28 | 30 | 86 | 53 | 56 | 59 |
| 9 | 8 | 9 | …. | 39 | 27 | 28 | 31 | 88 | 54 | 57 | 60 |
| 10 | 9 | 10 | …. | 40 | 27 | 29 | 31 | 90 | 55 | 58 | 61 |
| 11 | 10 | 11 | 11 | 41 | 28 | 30 | 32 | 92 | 56 | 59 | 63 |
| 12 | 10 | 11 | 12 | 42 | 28 | 30 | 32 | 94 | 57 | 60 | 64 |
| 13 | 11 | 12 | 13 | 43 | 29 | 31 | 33 | 96 | 59 | 62 | 65 |
| 14 | 12 | 13 | 14 | 44 | 29 | 31 | 34 | 98 | 60 | 63 | 66 |
| 15 | 12 | 13 | 14 | 45 | 30 | 32 | 34 | 100 | 61 | 64 | 67 |
| 16 | 13 | 14 | 15 | 46 | 31 | 33 | 35 | | | | |
| 17 | 13 | 15 | 16 | 47 | 31 | 33 | 36 | | | | |
| 18 | 14 | 15 | 17 | 48 | 32 | 34 | 36 | | | | |
| 19 | 15 | 16 | 17 | 49 | 32 | 34 | 37 | | | | |
| 20 | 15 | 17 | 18 | 50 | 33 | 35 | 37 | | | | |
| 21 | 16 | 17 | 19 | 52 | 34 | 36 | 39 | | | | |
| 22 | 17 | 18 | 19 | 54 | 35 | 37 | 40 | | | | |
| 23 | 17 | 19 | 20 | 56 | 36 | 39 | 41 | | | | |
| 24 | 18 | 19 | 21 | 58 | 37 | 40 | 42 | | | | |
| 25 | 18 | 20 | 21 | 60 | 39 | 41 | 44 | | | | |
| 26 | 19 | 20 | 22 | 62 | 40 | 42 | 45 | | | | |
| 27 | 20 | 21 | 23 | 64 | 41 | 43 | 46 | | | | |
| 28 | 20 | 22 | 23 | 66 | 42 | 44 | 47 | | | | |
| 29 | 21 | 22 | 24 | 68 | 43 | 46 | 48 | | | | |
| 30 | 21 | 23 | 25 | 70 | 44 | 47 | 50 | | | | |

The nine-point hedonic scale is a popular method used for preference testing. The term hedonic is defined as "having to do with pleasure". Here the member expresses his degree of liking or disliking in the following way:

- Like extremely
- Like very much
- Like moderately

- Like slightly
- Neither like nor dislike
- Dislike slightly
- Dislike moderately
- Dislike very much
- Dislike extremely

The results are analysed using Analysis of Variance. If only two samples are to be compared the mean scores received by each can be compared using t-test.

**Ranking**
When ranking for preference, the member is presented with coded samples to rank in order of preference. The results are analysed statistically. Generally, 2-digit or 3-digit codes are given to samples to avoid bias.

**Discriminatory or Difference Tests**
The important and effective test methods used to measure subjectively the difference between samples are Triangle test and Duo-trio test.

**Triangle Test**
When a new product developed has to be tested whether it is equal or superior to the existing one, then this test is done. Three coded samples all coded in 3-digit numbers to eliminate bias of which 2 samples belong to Product A and 1 sample belongs to Product B are provided to the panel members and asked to select the old sample. Now the same test is repeated with 2 samples of Product B and 1 sample of product A. When 10 judgments are there, we get 20 sets of choices for both the products. Using Table 2, the superiority of the Product developed against the existing product can be found out. For example, we use a panel of 25 judges and perform triangular test. We need a score of 23 or 26 to prove the superiority of the new product at 5% or 1% respectively and the number of judgments here is 50. The results of the triangular test indicate whether there is a detectable difference or not between the two samples.

**Table 2: Number of correct identifications required for significance at various levels in Triangle test. Chance probability is 33.3 per cent and the hypothesis is one-tailed**

| No. of judgments | Minimum Number required | | | No. of judgments | Minimum Number required | | | No. of judgments | Minimum Number required | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 % | 1 % | 0.1 % | | 5 % | 1 % | 0.1 % | | 5 % | 1 % | 0.1 % |
| 1 | …. | …. | …. | 31 | 16 | 18 | 20 | 72 | 32 | 34 | 38 |
| 2 | …. | …. | …. | 32 | 16 | 18 | 20 | 74 | 32 | 35 | 39 |
| 3 | 3 | …. | …. | 33 | 17 | 18 | 21 | 76 | 33 | 36 | 39 |
| 4 | 4 | …. | …. | 34 | 17 | 19 | 21 | 78 | 34 | 37 | 40 |
| 5 | 4 | 5 | …. | 35 | 17 | 19 | 22 | 80 | 35 | 38 | 41 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 5 | 6 | …. | 36 | 18 | 20 | 22 | 82 | 35 | 38 | 42 |
| 7 | 5 | 6 | 7 | 37 | 18 | 20 | 22 | 84 | 36 | 39 | 43 |
| 8 | 6 | 7 | 8 | 38 | 19 | 21 | 23 | 86 | 37 | 40 | 44 |
| 9 | 6 | 7 | 8 | 39 | 19 | 21 | 23 | 88 | 38 | 41 | 44 |
| 10 | 7 | 8 | 9 | 40 | 19 | 21 | 24 | 90 | 38 | 42 | 45 |
| 11 | 7 | 8 | 10 | 41 | 20 | 22 | 24 | 92 | 39 | 42 | 46 |
| 12 | 8 | 9 | 10 | 42 | 20 | 22 | 25 | 94 | 40 | 43 | 47 |
| 13 | 8 | 9 | 11 | 43 | 21 | 23 | 25 | 96 | 41 | 44 | 48 |
| 14 | 9 | 10 | 11 | 44 | 21 | 23 | 26 | 98 | 41 | 45 | 48 |
| 15 | 9 | 10 | 12 | 45 | 21 | 24 | 26 | 100 | 42 | 46 | 49 |
| 16 | 9 | 11 | 12 | 46 | 22 | 24 | 27 | | | | |
| 17 | 10 | 11 | 13 | 47 | 22 | 24 | 27 | | | | |
| 18 | 10 | 12 | 13 | 48 | 22 | 25 | 27 | | | | |
| 19 | 11 | 13 | 14 | 49 | 23 | 25 | 28 | | | | |
| 20 | 11 | 13 | 14 | 50 | 23 | 26 | 28 | | | | |
| 21 | 12 | 13 | 15 | 52 | 24 | 26 | 29 | | | | |
| 22 | 12 | 14 | 15 | 54 | 25 | 27 | 30 | | | | |
| 23 | 12 | 14 | 16 | 56 | 26 | 28 | 31 | | | | |
| 24 | 13 | 15 | 16 | 58 | 26 | 29 | 32 | | | | |
| 25 | 13 | 15 | 17 | 60 | 27 | 30 | 33 | | | | |
| 26 | 14 | 15 | 17 | 62 | 28 | 30 | 33 | | | | |
| 27 | 14 | 16 | 18 | 64 | 29 | 31 | 34 | | | | |
| 28 | 15 | 16 | 18 | 66 | 29 | 32 | 35 | | | | |
| 29 | 15 | 17 | 19 | 68 | 30 | 33 | 36 | | | | |
| 30 | 15 | 17 | 19 | 70 | 31 | 34 | 37 | | | | |

**Duo-trio test**

Initially three samples are given to the panel members of which one is the reference sample or control and the other two are test samples. Among the test samples, one is identical with the reference sample. The members are asked to taste and identify the odd sample. In Duo-trio test, the panelist has to judge any difference that can be detected. This test has same applications as that of triangle test but less efficient because the chance of selecting the correct sample by chance is 50%. Sensory evaluation is very important in marketing management to predict the acceptability of a product. No laboratory techniques are available to predict the acceptability of a product - it wholly depends on the sensory testing ability of the 'taste panel'. So, care should be taken to constitute taste panels for better predictability.

**References**

Luce, R. and Tukey, J.W. (1964) Simultaneous conjoint measurement: A new type of fundamental measurement. *Journal of mathematical psychology 1*: 1-27.

Gifi (1990) Non-linear multivariate analysis. New York. N.Y., Wiley.

Green, P.E. and Rao, V.R. (1971) Conjoint measurement of quantifying judgemental data. *Journal of marketing research 8*(3): 355-63.

Young, F.W. (1990) Quantitative analysis of qualitative data *Psychometrika 46*: 357-87.