Using Conjoint Analysis To Generate A New Customer Based Food Menu Case Study: Art University Of Tehran – Iran

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Abstract:
This paper tries to use conjoint analysis as a powerful data mining tool in generating a new product/service (food menu for this case). Conjoint analysis is used for multiattribute product/service and specifies customer ‘s preference in choosing different combination of attributes that compose a product/service. A traditional conjoint methodology has been explained step by step. Clustering analysis and logit model also are applied to determine segments of customers and simulation the market share respectively.

Key words: traditional conjoint analysis – market segmentation – customer preferences – clustering analysis – market share – data mining application in new product development

1. Introduction.

Conjoint analysis is a methodology for consumer studies which is suitable for studying the effect of a number of product factors on consumer acceptance, preference or choice (Isabella Endrizzi, 2011). Conjoint Analysis (CA) is an experimental approach for measuring consumer’s preferences about a product or service (Min Seok , So Young Sohn , Yong Han Ju , 2010). It refers to a set of procedures that investigate responses to mixtures of independent stimuli in an attempt to understand the contributions of these stimuli to the mixture (Moskowitz H R , Silcher M, 2006) . Conjoint analysis is a survey and analysis technique, which estimates the value people place on different attributes or features that define concepts, products and services (Bass FM, 1969). An academic history of conjoint measurement would start with the seminal paper by (Luce R D, Tukey J, 1964) in the first issue of the Journal of Mathematical Psychology and the work of (Kruskal J B, 1965). The varied developments and variants of Conjoint Measurement are summarized by (Green P E , Srinivasan V, 1978). The purpose of CA is to estimate utility scores, called part-worths, for product or service characteristics (Green P E, Krieger A M , Agarwal M K, 1991). Utility scores are subjective measures of how important each characteristic is to the respondent’s overall preference for a product and is determined by the particular combination of attributes and the personal characteristics of individuals. By combining the utilities for different attributes, the individual’s overall relative utility is provided (Singh J, 1998).

Before discussing how to design the conjoint analysis experiment , it is better to understand some uses of CA in terms of its role in decision making , market researchs and new product/service development. As it mentioned previously, CA assumes that any products , services or concepts are a combination of a set of attributes (factors) that researcher should determine them. The possible values for each factor, called levels . Combining the selected levels of each factor , researcher constructs a set of real or hypothetical products/services. These combinations are then presented to the consumers to obtain their overall preference , evaluation , utility or worth. This utility is based on the worth of each level, called part-worth. The purpose of CA is to estimate these part-worths and then the contribution of each factor to the consumer ‘s overall preference. Now the researcher can apply this information in many issues (Hair, Black, Babin, & Anderson, 2004, p. 398) such as:

- to define object or concept with the optimum combination of features (factors)
- to show the relative contribution (importance) of each attribute and level to the overall evaluation of the object

- to use estimates of customer judgments to predict preferences among objects with differing sets of features (other things held constant)
- to isolate groups of potential customers who place differing importance on the features to define high and low potential segment
- to identify marketing opportunities by exploring the market potential for feature combinations not currently available

The following papers show some recent efforts in associated with the managerial use of the conjoint analysis (note that most of them have been published in journal of Food Quality And Preference) : Identifying and interpreting market segments (Tormod Næs, 2001) , Consumer preference for bluefin tuna (Ariji, 2010) , Consumer perceived about Milk Desserts (Gastón Ares, 2009), consumer willingness to pay for a basic and an improved ready made soup product (Klaus G. Grunert, 2009) , Using simulations to measure consumer sensitivity to brand, region, price, and awards in wine choice (Larry Lockshina, 2006), Combining extrinsic and intrinsic information in consumer acceptance studies (Elena Menichellia, 2011) , Influence of three non-sensory factors on consumer choice of functional yogurts over regular ones (Gastón Aresa, 2010) , understanding Australian consumers' perceptions of selenium and motivations to consume selenium enriched foods (David N. Cox, Kathryn Bastiaans, 2007), Uncovering the mind-sets of consumers towards food safety messages (Aurora A. Sauloa, 2011), Consumer 's acceptance of innovations in dry-cured ham (Margrethe Hersletha, 2011),

2. Framework.

In this part it is shown how to design a conjoint analysis experiment based on a 7stages procedure (Hair, Black, Babin, & Anderson, 2004, pp. 400-419):

Stage 1 : research problem
Stage 2 : design of a conjoint analysis
Stage 3 : assumptions
Stage 4 : selecting an estimation technique (estimating the conjoint model and assessing the overall fit)
Stage 5 : interpreting the results
Stage 6 : validating the results
Stage 7 : applying the conjoint results (managerial application)

As with any statistical analysis , the starting point is the research question. The objective of this paper is to define the total utility of a food menu as a multi-attribute object. To be sure that the total utility of object would be define accurately , it is needed to consider all possible attributes (factors) either positive or negative. In order to comprise a wider range of attributes , this paper assumes a hypothetical model beside the actual one. So this hypothetical model would be more general and useful for other cases.

Determining the factors is going to be the next step. The factors of hypothetical model are determined at first and then considering the condition of our case ,the factors of actual model will be chosen among the hypothetical one. For the general (hypothetical) model, the following factors could describe the total utility relatively complete.

Table 1. Tthe factors of the general model

Factors	Description
1-starter	Including starter menu
2-main course	Including main course menu
3-dessert	Including dessert menu
4-place	Including places for serving a meal – for some cases such as hotels , the place of serving the meal is important. In room services – at the restaurant – at the snack bar – at the beach
5-time	Including time limits
6- salads	Including Salad menu
7-drinks	Including Drink menu
8-extra service	Including extra services menu – may be in binary format (yes – no)
9-additional menu	Including additional menu such as yogurt , olive , pickle
10-price	Including price levels
11-brand	Including brand list

Determining the factors of the general model , the actual model 's factors should be chosen. Note that one of the important issues associated with the current step is to specify the determinant factors (Hair, Black, Babin, & Anderson, 2004, p. 403) which best differentiate between objects (stimuli). According to this condition and other limitations of the case , all above factors would be reviewed to see if they are consistent with implied limitations or not. and the inconsistent ones would be omitted.

Starter , dessert and extra services would be omitted due to university 's unavailability to provide such services. Price , brand , time and place would be omitted as a result of that they are fixed and constant in the case. So they could not differentiate among stimuli and not included as determinant factors. At the art university

of Tehran , the meal (main course , as a lunch) just come with one particular item such as drink , salad or one of the additional menu ‘s item , in a single day. In this way it is better to consider additional menu as one factor including salads , drinks and former additional menu , rather than 3 factors. Thus , the determinant factors for the actual model are denoted as follows :

Table 2. The factors of the actual model

Factors	Description
1-main course	Including main course menu
2-additional menu	Including additional menu such as yogurt , olive , pickle , salad and drinks

After the basic attributes that constitute the utility were determined , a fundamental question must be resolved : which of the three basic conjoint analysis methodology (traditional , adaptive , choice based) should be used ? the choice of conjoint methodologies revolves around three basic characteristics (Hair, Black, Babin, & Anderson, 2004, p. 404):

1-number of attributes handled , 2-level of analysis , 3-permitted model form

The following table , best describes a comparison of alternative conjoint methodologies (Hair, Black, Babin, & Anderson, 2004, p. 404) :

Table 3. A comparison of alternative conjoint methodologies

characteristic	traditional	adaptive	Choice based
Max no. of attributes	9	30	6
Level of analysis	individual	individual	aggregate
Model form	additive	additive	Additive + interaction effects

Considering that the case has just 2 factors (attribute) and the price as a factor that causes interaction effect, is not used , although the experiment would be in aggregate level , traditional methodology is going to be the best alternative.

The next issue must be addressed at this step , is to define factor levels to be included in constructing the stimuli. Before representing the stimuli to respondents , the researcher should ensure that the measures are both communicable and actionable (Hair, Black, Babin, & Anderson, 2004, p. 405). To be communicable means that the factors and levels must be easily communicated for a realistic evaluation. For example it is difficult to describe of a perfume or feel of a hand lotion. To be actionable means that the factors and levels must also be capable of being put into practice , in other words attributes must be distinc and represent a concept that can be precisely implemented. They must not be fuzzy such as overall quality and convenience. The factors of the actual model represented in table 2 , are both communicable and actionable. Another point regarding factor levels is that the researcher should attempt as best possible to balance the number of levels across factors. It has been found that the estimated relative importance of a variable (factor) increases as the number of levels increases , even if the end point s stay the same (Hair, Black, Babin, & Anderson, 2004, p. 407).

In view of the issues discussed above and the Art University Of Tehran’s potential , the factor levels for the actual model would be as follows:

Table 4. The factor levels for the actual model

Factors	levels
1-main course	Ghorme sabzi – gheime - lentil and rice – roast chicken – kebab – beans and rice – macaroni - fish
2-additional menu	yogurt - pickle - salad – cola – dough – banana – caramel - juice

Specifying the basic model form is the next issue. As the traditional methodology has been selected previously , the basic model form is going to be additive. In additive form , respondents simply add up the value for each attribute to get the total value for a combination of attributes (products or services) (Hair, Black, Babin, & Anderson, 2004, p. 408).

Another issue must be addressed at this step , is to select the part-worth relationship. meaning that how the levels of a factor are related. The relationship among levels of a factor , could be in three types : 1-linear 2- quadratic or ideal point 3-separate part-worth (Hair, Black, Babin, & Anderson, 2004, p. 411). Due to

inherent characteristic of the factors , there is no relationship among their levels . Therefore the separate part-worth should be selected.

After specifying the relationship among factor levels , the presentation method should be chosen. Trade-off , full-profile and pair-wise comparison are the three methods of stimulus presentation most widely associated with conjoint analysis (Hair, Black, Babin, & Anderson, 2004, p. 412). Full-profile method would be chosen due to the number of factors and the fact that the full-profile is the most popular method because of its perceived realism and its ability to reduce the number of comparisons through the use of fractional factorial designs.

And ultimately the measure of consumer preference should be selected between rank-ordering and rating. In view of the rank-ordering is likely to be more reliable than rating (Hair, Black, Babin, & Anderson, 2004, p. 417), it is going to be selected as a measure of preference.

Considering all of issues at this stage , the fractional factorial design for the additive (actual) model is indicated below:

Table 5. Fractional factorial design for additive model (main effects only estimated)

	Card ID	main course	additional menu
1	1	kebab	pickle
2	2	kebab	yogurt
3	3	lentil and rice	juice
4	4	fish	salad
5	5	macaroni	cola
6	6	ghorme sabzi	dough
7	7	lentil and rice	banana
8	8	macaroni	yogurt
9	9	roast chicken	salad
10	10	gheime	pickle
11	11	roast chicken	juice
12	12	gheime	caramel
13	13	beans and rice	caramel
14	14	ghorme sabzi	cola
15	15	beans and rice	dough
16	16	fish	banana
17a	17	gheime	dough
18a	18	lentil and rice	pickle
19a	19	fish	juice
20a	20	macaroni	salad

a. Holdout

Assumptions of Conjoint Analysis

Conjoint analysis has the least restrictive set of assumptions involving the estimation of the conjoint model. The structured experimental design and the generalized nature of the model , make most of the tests performed for other dependence methods unnecessary. Therefore , the statistical test for normality and homoscedasticity and independence that were performed for other dependence techniques are not necessary. Yet even though there are fewer assumptions , the statistical conceptual assumptions are perhaps greater than with any other multivariate technique (Hair, Black, Babin, & Anderson, 2004, p. 418).

Estimating the Conjoint Model and Assessing the Overall Fit, interpreting the result & validation

Rank-order evaluations require a modified form of analysis of variance specially designed for ordinal data (Hair, Black, Babin, & Anderson, 2004, p. 419). The SPSS 18 is used as a computer program for the case.

The sample size used for analysis is 148. The size of the sample in conjoint analysis varies considerably. One report (Cattin P, Wittink D.R, 1982) declares that the size of the sample in commercial conjoint studies ranges from 100 to 1000 , with 300 to 550 the most typical range. In another study (Akaah I P, P.K. Korgaonkar, 1988) it is found that smaller size (less than 100) are typical.

Table 6 represents the estimation of part-worth for aggregate result:

Table 6. Conjoint analysis result for the overall sample

Utilities

		Utility Estimate	Std. Error
Main	Ghorme Sabzi	-.136	.655
	Roast Chicken	.594	1.010
	Kebab	.378	.557
	Beans And Rice	-.217	.816
	Lentil And Rice	-.285	.816
	Macaroni	-.149	.557
	Fish	.019	.816
	Gheime	-.204	.655
Additional	Cola	.027	.567

	Yogurt	.115	.567
	Caramel	.480	.823
	Pickle	-.081	.663
	Dough	.088	.663
	Banana	.345	.924
	Juice	-.912	1.016
	Salad	-.061	.823
(Constant)		8.413	.161

As the table 6 shows , the top five favorite main courses are respectively 1-roast chicken 2-kebab 3-fish 4-ghorme sabzi 5-macaroni and the top five for additional menu are 1-caramel 2-banana 3-yogurt 4-dough 5-cola . the relative importance value of two factors are shown below :

Table 7. Relative importance of the factors

	Importance Values
main	49.393
additional	50.607

Surprising result of table 7 shows the high importance of additional menu in respondent‘s decision making structure. It is somehow more important than main course.

Table 8. Predictive accuracy for overall sample

	Value	Sig.
Pearson's R	.892	.000
Kendall's tau	.728	.000
Kendall's tau for Holdouts	.667	.087

Correlations between observed and estimated preferences

The high levels of predictive accuracy for both the estimation and holdout stimuli across respondents , confirm the additive composition rule for this set of respondents.

Managerial Application : Market Segmentation & Choice Simulator

One of the most common uses of individual –level conjoint analysis result is to group respondent with similar part-worth or importance values to identify segments (Hair, Black, Babin, & Anderson, 2004, p. 422). It means that the estimated conjoint part-worths can be used to derive segment of respondent that are similar in their estimated preferences. But this paper tries to show that segmenting respondents in terms of their actual preference (not estimated) would lead to an acceptable result. To achieve this goal , the k-means clustering algorithm is applied and the respondents would be grouped by their stimuli ranking. Note that the k-means technique lets the researcher to determine the number of clusters before running the program. Regarding the art university of Tehran ‘s potential in providing food menus in a single day , it is decided to consider only two segments (cluster) . using the spss18 , the output of k-means clustering would be as follows :

Table 9. Clustering analysis results

Number of Cases in each Cluster

Cluster	1	67.000
	2	81.000
Valid		148.000
Missing		.000

As the table 9 depicts, respondents were grouped into two cluster (segments) where cluster 1 contains 67 respondents (45.9%) and cluster 2 consists of 81 respondents (54.1%). To describe the similarity within each cluster, the conjoint analysis would be applied again for each cluster separately.

Table 10. Conjoint analysis results for cluster 1

	Utility Estimate	Std. Error

main	ghorme sabzi	-.604	.281
	roast chicken	.336	.434
	kebab	.291	.239
	beans and rice	.739	.350
	lentil and rice	-.097	.350
	macaroni	-.366	.239
	fish	.112	.350
	gheime	-.410	.281
additional	cola	.537	.244
	yogurt	-.045	.244
	caramel	.134	.353
	pickle	-.090	.285
	dough	.463	.285
	banana	-.881	.397
	juice	-.343	.436
	salad	.224	.353
(Constant)		8.470	.069

Importance Values

main	49.132
additional	50.868

Averaged Importance Score

Correlations

	Value	Sig.
Pearson's R	993	.000
Kendall's tau	979	.000
Kendall's tau for Holdouts	333	.248

Correlations between observed and estimated preferences

Table 11. Conjoint analysis results for cluster 2

Utilities

		Utility Estimate	Std. Error
main	ghorme sabzi	.252	1.429
	roast chicken	.807	2.205
	kebab	.449	1.216
	beans and rice	-1.008	1.781
	lentil and rice	-.440	1.781
	macaroni	.029	1.216
	fish	-.057	1.781
	gheime	-.032	1.429
additional	cola	-.395	1.238
	yogurt	.247	1.238
	caramel	.765	1.795
	pickle	-.074	1.448

	dough	-.222	1.448
	banana	1.358	2.017
	juice	-1.383	2.217
	salad	-.296	1.795
(Constant)		8.366	.351

Table 10 and 11 helps to describes some specifications of each cluster. The top five favorite main courses for cluster1 are respectively : 1-beans and rice 2-roast chicken 3-kebab 4-fish 5-lentil and rice and for cluster2 it is : 1-roast chicken 2-kebab 3-ghorme sabzi 4-macaroni 5-gheime. As well the rank for additional menu across the clusters is as follows : for cluster1 : 1-cola 2-dough 3-salad 4-caramel 5-yogurt. For cluster2 : 1-banana 2-caramel 3-yoguet 4-pickle 5-dough.

Looking carefully to results , confirms that the highlighted difference between the clusters is related to the utility scores of beans and rice and ghorme sabzi according to main course and banana and cola in terms of additional menu. It also depicts that roast chicken and kebab are two favorable main courses for both clusters as well as caramel and yogurt in additional menu. In addition , the relative importance of factors declares that there is no difference between two clusters in terms of valuing on factors.

Since the goal of all clustering techniques is to maximize heterogeneity across clusters and homogeneity within each cluster, the increase of overall fit (model accuracy) is expected in each clusters. The values of Kendall's tau (suited for ordinal variable) indicate this expected increase (.728 for overall sample , .979 for cluster1and .767 for cluster2).

Choice simulator is used to obtain preference probability of stimuli. It is also applied to validate conjoint model (Hair, Black, Babin, & Anderson, 2004, p. 423). The following sets of stimuli are selected for simulation of respondent choices (output of SPSS 18):

3. Conclusion.

The outcomes obtained from this methodology could be used in new product development. Estimated part-worths, segments of market and simulation results (market share of each stimuli) have a direct impact on first four stages of concept development procedure.

Note that the results of this methodology just come from customer ‘s preferences and not from company/organization ‘s preferences. Because it does not take into account important parameters such as time , cost , capability and other restrictive parameters in production or service. On the other hand these outcomes provide company/organization diverse sets of choices and scenario in product /service development. So regarding company/organization ‘s strategy (strengths , weaknesses , threats and opportunities) , these outcomes could be best used for more success as well as the case of this study. Serving just one menu (according to overall sample results) or providing two different types of menu (according to clustering results) for students in a single day, depends on Art University of Tehran ‘s strategy.

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