

# CONJOINT ANALYSIS

L C Koo Ph D  
Associate Professor  
International Management Centres – Oxford Brookes University

## STATEMENT OF THE PROBLEM

In a typical process / delivery chain, one has to be aware of who are his suppliers (i.e. those before him in the chain) and who are his customers (i.e. those following him) who receive the service or product from him. It is vitally important to know what the requirements of the customers are and then to ensure their needs are met or exceeded. On the other hand it is also necessary to know the constraint and capacity of the suppliers in order to deliver good output to the customers.

The problem which most people encounter is the difficulty to accurately identify and measure the needs of the customers (or sometime the suppliers). One simple approach is to ask what they need. However in practice, the respondents may not really know their own needs. At best they have a vague idea. In the rare occasion when the respondents know their needs, they are still not able to quantify their needs specifically enough to make prediction for other combinations of product / service attributes.

In the building and construction industry, Conjoint Analysis can be a very powerful and practical technique to measure the importance level different groups (customers, designers, architects, builders, property agents, property developers ... etc.) attach to a particular attribute (such as age of building, area, direction, price, location, floor, view). Knowing these utilities for different segments, the building operators can make informed decision in devising effective business strategies best suited to serve their specific market segments. Conjoint Analysis can measure how much customer satisfaction a change in product or service attribute will offer relative to another kind of changes. It helps determine which of the two potential changes is the more valuable and effective.

Conjoint Analysis research studies have been conducted in a wide variety of business sectors e.g. credit card, grocery and candy products, life insurance, retailing, health club service retailers, eggs, wine, financial service, beef retailing, and property. It is well suited to tackle the problem of identifying and measuring “utilities” of customers in the building and construction industry.

This chapter would describe how Conjoint Analysis could be applied to measure the utilities of various building and construction attributes among interested parties. Knowing which utility cues are most important to a particular customer group, the operators can determine what should be emphasised, developed and promoted in order to lure these desired customers from their competitors. They can also make predictions about customers’ purchase intentions in responses to changes to these utility cues. Using these utilities in conjunction with other customer information (e.g. demographics, psychographics) the operators can more effectively segment the market.

## CONJOINT ANALYSIS AS A SOLUTION TO THE PROBLEM

Traditional research techniques in assessing consumer preference tend to treat each attribute independently. These attribute preference data so obtained using Likert scale provide very little information on how consumers are likely to make a favourable or unfavourable buying decision. Customers do not consider each of these attributes singly and independently when making a choice. Instead they would consider the whole range of product attributes in totality and not individually. Conjoint based approach can help understand how customers trade off one product attribute against another. Conjoint Analysis which engages the respondents in a more realistic judgement stance than

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do other research methods, can better predict the overall customer preference through aggregating the utility scores of all individual product attributes. It has become a popular method for identifying and understanding the combined effects of product attributes on preferences for a product / service. It enables not only the assessment of product attributes in a multi-cue setting, but also the quantification of the effect in terms of utility values. The incorporation of customised set of attributes for different respondents enables the impact of different product attributes to be analysed in the context of cues directly relevant to particular market segments.

Conjoint Analysis can also be called “trade-off analysis” or “utility analysis”. Two basic assumptions are made in Conjoint Analysis. Firstly, a product / service can be described as a combination of levels of a set of attributes. Secondly, these attribute levels determines consumers’ overall judgement of the product / service.

The attraction of using Conjoint Analysis is that it asks the respondents to make choices between products defined by a unique set of product attributes in a way resembling what they normally do - by trading off features, one against the other. When asked which attributes they would like, most customers will choose everything on the wish list. Conjoint can establish the relative values of particular attributes and identifies the trade-offs the customers are likely to make in choosing a product and service and the price they are willing to pay for it. The relative importance of each attribute can be calculated as the utility-range (i.e. difference between the highest and the lowest utility for that attribute) divided by the sum of utility ranges of all attributes. Conjoint Analysis generates two important results :

- **Utility of attribute:** *It is a numerical expression of the value consumers place in an attribute level. It represents the relative “worth” of the particular attribute level. Low utility indicates less value; high utility indicates more value. (An attribute can be a particular product feature e.g. color and an attribute level is a specific characteristic of that product feature e.g. red, green, blue ...etc)*
- **Importance of attribute:** *It can be calculated by examining the difference between the lowest and highest utilities across the levels of attributes (i.e. range of the attribute utilities) and dividing the individual utility range with the total of all utility ranges.*

Conjoint Analysis is a powerful technique which models how customers make trade-off decisions among multi-attribute products or service. It assumes that alternative product concepts can be defined as a series of specific levels of a common set of attributes. It also assumes that the total utility the consumer derives from a product is the aggregate of the respective utilities (part-worths) contributed by each attribute level.

The objectives of Conjoint Analysis are to identify attribute combinations which give the highest utility to the customer and to establish the relative importance of attributes in terms of their contribution to total utility. Subsequent analyses can be conducted to identify customer segments with similar preferences and the simulation of choices among alternative product concepts using choice simulation models.

Conjoint-based method of preferential segmentation outperforms other techniques in that it provides a higher level of intra-group homogeneity and inter-group heterogeneity as far as the most preferred product / service design is concerned. It is extremely useful in customer segmentation.

## APPROACHES TO CONJOINT ANALYSIS

There are two general approaches to data collection for conjoint --- the two-factor-at-a-time trade-off method and the multiple factor full-concept method. The two-factor-at-a-time trade-off method is now seldomly used. The full-concept is more realistic as all factors are considered and evaluated at the same time.

In the full-concept (or full-profile), the respondents are asked to rank or score a set of profiles according to their preference. On each profile, all factors of interest are represented and a different combination of factor levels (i.e. features) appears. The factors are the general attribute categories of the product / service. The factor levels (i.e. product / service features) are the specific values of the factors. These are depicted in the following table:

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<b>Factors</b>	<b>Factor levels</b>
Age of building	Less than 5 years old 5 – 10 years old 10 – 15 years old Over 15 years old
Area of the property	500 sq feet 800 sq feet 1100 sq feet
Direction	East South West North
Price of property	3500 dollars per sq foot 4500 dollars per sq foot 5500 dollars per sq foot 6500 dollars per sq foot 7500 dollars per square foot
Building Location (measured by travelling time from home to work)	10 minutes 30 minutes 50 minutes 70 minutes
Floor Location	Low floor Middle floor High floor
View available	Sea view Garden view School or Building view No view at all

Fig. 1: Example of Factors and Factor Levels

The possible combinations of all factor levels can become too large (e.g. in the above example it amounts to:  $4 \times 3 \times 4 \times 5 \times 4 \times 3 \times 4 = 11,250$  combinations) for respondents to rank or score in a meaningful way. The full-concept approach available in statistical package (e.g. SPSS Categories) uses fractional factorial design, which uses a smaller fraction of all possible alternatives. This reduced size subset (orthogonal array) considers only the main effects and the interactions are assumed to be negligible. For this particular example, the orthogonal array profile needs only 32 cases in the attribute profile sheet (see appendix).

The factor levels can be specified as DISCRETE for factor levels which are categorical; LINEAR for data which are expected to be linearly related to the factor; IDEAL for quadratic function models which when plotted would look like an inverted 'U', or ANTIIDEAL for quadratic function models which when plotted would look like a 'U'.

The SPSS Conjoint procedure can calculate utility scores (or part-worths) for each individual respondent and for the whole sample. By incorporating some demographic data in the attribute profile sheet, the utility pattern for each segment can be discerned. These utility scores, analogous to regression coefficients, can be used to find the relative importance of each factor. SPSS permits the use of simulation profiles to represent actual or prospective products to estimate or predict market share of preference.

#### EXAMPLE TO SOLVE THE PROBLEM OF IDENTIFYING USERS' UTILITIES IN PURCHASING A PROPERTY

The first step in Conjoint Analysis is to identify the various factors and their respective factor levels relevant to the problem to be tackled. This can be done through some focus group discussions. The statistical software will be used to generate an orthogonal design for the appropriate factors (i.e. attributes) and factor levels. Respondents were briefed about the concept of utility and they were

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asked to score the 32 profiles.

The following is the summary result of 17 respondents who were selected from the middle income group working in the service industry in Hong Kong. They were all permanent residents and many of them have prior experience of selecting and purchasing a property.

Averaged Importance	Utility	Factor	
<b>AGE</b>			
+-----+			
I11.92I	3.0717	I--	Less than 5 years old
+-----+	2.3070	I-	5 - 10 years old
I	-2.4945	--I	10 - 15 years old
I	-2.8842	--I	Over 15 years old
I			
+-----+			
<b>AREA</b>			
I18.63	I -6.4142	----I	500 Sq ft
+-----+	2.9608	I--	800 Sq ft
I	3.4534	I--	1100 Sq ft
I			
+-----+			
<b>DIRECTN</b>			
I11.50I	.3658	I	East
+-----+	3.3143	I--	South
I	-2.1857	-I	West
I	-1.4945	-I	North
I			
+-----+			
<b>PRICE</b>			
I20.82	I 6.6279	I----	HK\$ 3500 per sq ft
+-----+	2.7235	I--	HK\$ 4500 per sq ft
I	-.0779	I	HK\$ 5500 per sq ft
I	-3.9088	--I	HK\$ 6500 per sq ft
I	-5.3647	---I	HK\$ 7500 per sq ft
I			
+-----+			
<b>LOC</b>			
I15.90	I 5.6599	I---	10 mins travel to work
+-----+	3.5570	I--	30 mins travel to work
I	-2.8842	--I	50 mins travel to work
I	-6.3327	----I	70 mins travel to work
I			
+-----+			
<b>FL</b>			
7.59	I I -3.1103	--I	Low floor
+-----+	1.2059	I-	Middle floor
I	1.9044	I-	High floor
I			
+-----+			
<b>VIEW</b>			
I13.64	I 4.3805	I---	Sea view
+-----+	2.5129	I--	Garden view
I	-.5754	I	School or Building view
I	-6.3180	----I	No view at all
I			
+-----+			
<b>CONSTANT</b>			
	47.5547		
Pearson's R	= .982	Significance	= .0000
Kendall's tau	= .895	Significance	= .0000

**Fig. 2: The Conjoint summary results of property purchase utilities in Hong Kong**

The estimated score for any combination of the factor levels can be estimated by the following equation:

$$\text{Estimated preference score} = \text{Constant} + \sum (\text{utility scores of relevant factor levels})$$

As an example for a profile of the following factor level combination (with the respective utility score in bracket), the score can be estimated by employing the above equation.

5 – 10 years old building	(2.31)
800 sq feet	(2.96)
South	(3.31)
HK\$5500 per sq foot	(-0.08)

30 minutes travel to work	(3.56)
Middle floor	(1.21)
Sea view	(4.38)

$$\begin{aligned} \text{Estimated preference score} &= 47.55 + 2.31 + 2.96 + 3.31 - 0.08 + 3.56 + 1.21 + 4.38 \\ &= 65.2 \end{aligned}$$

The Pearson's R (for measure of association for linear relationship) and Kendall's tau (for measure of association of ordinal data) is an indication of how well the model fits the data. They are correlations between the observed and estimated preferences.

## RECOMMENDATIONS

The example cited earlier illustrates the usefulness of Conjoint Analysis in determining the utility values of property attributes. The utility scores are subjective measures to each respondent, who without the assistance of Conjoint Analysis would not know them. Yet in reality every customer makes decisions based on the implicit utilities he or she attaches to each factor. Marketers or developers can use this powerful research technique to reveal and measure the hidden needs of the customers.

Conjoint Analysis can provide much needed information for property operators who want to cater some special customer groups by finding a suitable market niche for their operations. Yet very often when asked whether they know what their customers' "real" needs are, they have no confidence and lack reliable answers. Even if they want to develop their business strategies, they have no relevant data to work with. Much managerial decisions are inevitably based on hunch or on past experience. They cannot reliably predict the likely outcome arising from their decisions and actions.

A word of caution in using Conjoint Analysis is the limitation on the selection of factors and factor levels. Even with the help of orthogonal array design, the number of profiles can still be very large. The users need to choose the appropriate factors and factor levels. If important factors are omitted then the application of the Conjoint Analysis findings would be greatly impaired. Therefore proper research planning is vitally important before administrating the conjoint attribute profile sheet on the respondents. The other issue relates to the choice of respondents. They should be representative to meet the research objectives. The sample size should be large enough to give meaningful data analysis.

## Appendix

Name: \_\_\_\_\_

Gender: Male [  ]; Female [  ] (Please tick the appropriate one)

Property ownership in HK: Yes [  ]; Never [  ]; Previously owned but not now [  ]

*Please score the following choices from 0 (i.e. least preferred) to 100 (i.e. most preferred):*

### Choice 1

AREA 500 Sq ft  
FL Middle floor  
DIRECTN North  
VIEW School or Building view  
AGE Less than 5 years old  
LOC 30 mins travel to work  
PRICE HK\$ 5500 per sq ft (or \$ 2.75 M)

### Choice 2

AREA 500 Sq ft  
FL Middle floor  
DIRECTN North  
VIEW No view at all  
AGE 5 - 10 years old  
LOC 50 mins travel to work  
PRICE HK\$ 3500 per sq ft (or \$ 1.75 M)

### Choice 3

AREA 1100 Sq ft  
FL Middle floor  
DIRECTN East  
VIEW No view at all  
AGE 10 - 15 years old  
LOC 70 mins travel to work  
PRICE HK\$ 6500 per sq ft (or \$ 7.15 M)

### Choice 4

AREA 500 Sq ft  
FL Low floor  
DIRECTN South  
VIEW School or Building view  
AGE Over 15 years old  
LOC 50 mins travel to work  
PRICE HK\$ 6500 per sq ft (or \$ 3.25 M)

### Choice 5

AREA 1100 Sq ft  
FL Low floor  
DIRECTN East  
VIEW School or Building view  
AGE 5 - 10 years old  
LOC 30 mins travel to work  
PRICE HK\$ 4500 per sq ft (or \$ 4.95 M)

**Choice 6**

AREA 800 Sq ft  
FL High floor  
DIRECTN North  
VIEW Sea view  
AGE 5 - 10 years old  
LOC 10 mins travel to work  
PRICE HK\$ 6500 per sq ft (or \$ 5.2 M)

**Choice 7**

AREA 1100 Sq ft  
FL Low floor  
DIRECTN West  
VIEW No view at all  
AGE 5 - 10 years old  
LOC 10 mins travel to work  
PRICE HK\$ 5500 per sq ft (or \$ 6.05 M)

**Choice 8**

AREA 800 Sq ft  
FL High floor  
DIRECTN West  
VIEW No view at all  
AGE Over 15 years old  
LOC 30 mins travel to work  
PRICE HK\$ 5500 per sq ft (or \$ 4.4 M)

**Choice 9**

AREA 500 Sq ft  
FL High floor  
DIRECTN South  
VIEW School or Building view  
AGE 5 - 10 years old  
LOC 70 mins travel to work  
PRICE HK\$ 4500 per sq ft (or \$ 2.25 M)

**Choice 10**

AREA 500 Sq ft  
FL Low floor  
DIRECTN North  
VIEW No view at all  
AGE Over 15 years old  
LOC 70 mins travel to work  
PRICE HK\$ 3500 per sq ft (or \$ 1.75 M)

**Choice 11**

AREA 1100 Sq ft  
FL High floor  
DIRECTN North  
VIEW Garden view  
AGE Less than 5 years old  
LOC 70 mins travel to work  
PRICE HK\$ 7500 per sq ft (or \$ 8.25 M)

**Choice 12**

AREA 500 Sq ft  
FL Low floor  
DIRECTN North  
VIEW School or Building view  
AGE 10 - 15 years old  
LOC 10 mins travel to work  
PRICE HK\$ 5500 per sq ft (or \$ 2.75 M)

**Choice 13**

AREA 1100 Sq ft  
FL Low floor  
DIRECTN North  
VIEW Sea view  
AGE Over 15 years old  
LOC 30 mins travel to work  
PRICE HK\$ 4500 per sq ft (or \$ 4.95 M)

**Choice 14**

AREA 800 Sq ft  
FL Middle floor  
DIRECTN East  
VIEW School or Building view  
AGE Over 15 years old  
LOC 10 mins travel to work  
PRICE HK\$ 7500 per sq ft (or \$ 6.0 M)

**Choice 15**

AREA 1100 Sq ft  
FL Middle floor  
DIRECTN South  
VIEW Sea view  
AGE Less than 5 years old  
LOC 50 mins travel to work  
PRICE HK\$ 5500 per sq ft (or \$ 6.05 M)

**Choice 16**

AREA 800 Sq ft  
FL Low floor  
DIRECTN East  
VIEW No view at all  
AGE Less than 5 years old  
LOC 50 mins travel to work  
PRICE HK\$ 4500 per sq ft (or \$ 3.6 M)

**Choice 17**

AREA 1100 Sq ft  
FL Low floor  
DIRECTN South  
VIEW Garden view  
AGE Over 15 years old  
LOC 10 mins travel to work  
PRICE HK\$ 3500 per sq ft (or \$ 3.85 M)



**Choice 18**

AREA 500 Sq ft  
FL Low floor  
DIRECTN West  
VIEW Garden view  
AGE Less than 5 years old  
LOC 30 mins travel to work  
PRICE HK\$ 6500 per sq ft (or \$ 3.25 M)

**Choice 19**

AREA 800 Sq ft  
FL Low floor  
DIRECTN West  
VIEW School or Building view  
AGE Less than 5 years old  
LOC 70 mins travel to work  
PRICE HK\$ 3500 per sq ft (or \$ 2.8 M)

**Choice 20**

AREA 500 Sq ft  
FL Middle floor  
DIRECTN West  
VIEW Sea view  
AGE Over 15 years old  
LOC 70 mins travel to work  
PRICE HK\$ 4500 per sq ft (or \$2.25 M)

**Choice 21**

AREA 500 Sq ft  
FL Low floor  
DIRECTN South  
VIEW No view at all  
AGE 10 - 15 years old  
LOC 30 mins travel to work  
PRICE HK\$ 7500 per sq ft (or \$ 3.75 M)

**Choice 22**

AREA 800 Sq ft  
FL Low floor  
DIRECTN South  
VIEW Sea view  
AGE 10 - 15 years old  
LOC 70 mins travel to work  
PRICE HK\$ 5500 per sq ft (or \$ 4.4 M)

**Choice 23**

AREA 800 Sq ft  
FL Low floor  
DIRECTN North  
VIEW Garden view  
AGE 10 - 15 years old  
LOC 50 mins travel to work  
PRICE HK\$ 4500 per sq ft (or \$ 3.6 M)

**Choice 24**

AREA 800 Sq ft  
FL Middle floor  
DIRECTN South  
VIEW Garden view  
AGE 5 - 10 years old  
LOC 30 mins travel to work  
PRICE HK\$ 3500 per sq ft (or \$ 2.8 M)

**Choice 25**

AREA 1100 Sq ft  
FL High floor  
DIRECTN West  
VIEW School or Building view  
AGE 10 - 15 years old  
LOC 50 mins travel to work  
PRICE HK\$ 3500 per sq ft (or \$ 3.85 M)

**Choice 26**

AREA 500 Sq ft  
FL Low floor  
DIRECTN West  
VIEW Sea view  
AGE 5 - 10 years old  
LOC 50 mins travel to work  
PRICE HK\$ 7500 per sq ft (or \$ 3.75 M)

**Choice 27**

AREA 500 Sq ft  
FL Middle floor  
DIRECTN West  
VIEW Garden view  
AGE 10 - 15 years old  
LOC 10 mins travel to work  
PRICE HK\$ 4500 per sq ft (or \$2.25M)

**Choice 28**

AREA 500 Sq ft  
FL High floor  
DIRECTN South  
VIEW No view at all  
AGE Less than 5 years old  
LOC 10 mins travel to work  
PRICE HK\$ 4500 per sq ft (or \$2.25 M)

**Choice 29**

AREA 500 Sq ft  
FL Low floor  
DIRECTN East  
VIEW Sea view  
AGE Less than 5 years old  
LOC 10 mins travel to work  
PRICE HK\$ 3500 per sq ft (or \$ 1.75 M)

**Choice 30**

AREA 500 Sq ft  
FL Low floor  
DIRECTN East  
VIEW Garden view  
AGE 5 - 10 years old  
LOC 70 mins travel to work  
PRICE HK\$ 5500 per sq ft (or \$ 2.75 M)

**Choice 31**

AREA 500 Sq ft  
FL High floor  
DIRECTN East  
VIEW Sea view  
AGE 10 - 15 years old  
LOC 30 mins travel to work  
PRICE HK\$ 3500 per sq ft (or \$ 1.75 M)

**Choice 32**

AREA 500 Sq ft  
FL High floor  
DIRECTN East  
VIEW Garden view  
AGE Over 15 years old  
LOC 50 mins travel to work  
PRICE HK\$ 5500 per sq ft (or \$ 2.75M)