Conjoint analysis for strategic decisions: a case of two schools

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Abstract

The author(s) of this paper have developed the perceptual mapping for the parents of school-going-children's belonging to two different schools located at two different locations. These perceptions were related to four attributes/factors (i) 'Qualifications of Teachers' (QT), (ii) 'Average Experience of Teachers (AET)' (iii) 'Total Fee (Fee)' and (iv) 'Reputation of the School (RoS)' measured at three levels. Parents group 1 belonging to (low income group) were from school located in slum area (Location1- L1), and parents belonging to group 2 (high income group) were from school located in rich society (Location2-L2). The conjoint analyses had been employed for understanding perception of parents of two groups belongs to two locations L1 and L2 with respect to above four attributes. To minimize total runs, L9 orthogonal array Taguchi experimental designs had been selected for both locations. After identifying or developing virtual schools as per design runs, the selected & trained (Parent PTA members of each group rated the 9 different designs of schools of their respective location. Then the part/factor worth and percentage of importance had been calculated for each factor and each location that helped in recommending strategies to maximize parents' perception Index 83.00 for Location 1; and 82.67 for Location 2 which in-turn may help in maximizing the schools' admission growth rate.

1. Introduction

Most of the corporate/private school managements are in dilemma about issues related with increase in fees because of socio-economical problems like increased inflation, insufficient disposable income and inadequate infrastructure. The school managements are required to offer additional value in case of increase fees which is a key concern for school management.

Providing more value added services will definitely increase the new admission growth rate and also add a financial burden on school management to run the school under losses. High increase in fee and High value added service is good to school located at high-income group locality at the same time low-income parents may not be in a position to take admission. Low increase in fee and low value added service is better option for the school located at low income group locality at the same time high-income parents may not be in a position to take admission because of low value added services.

The general theory suggests that the schools' new-admission growth rate is directly proportional to the school infrastructure, teachers' quality/qualifications and teachers experience at the same time the 'growth rate' is inversely proportional to school fee. This means the ideal or the best school with respect to school-going children parents is the one which has world class infrastructure, highly qualified and experienced teachers and minimum/zero fees. This ideal condition is not feasible for the private/corporate schools managements. Hence the

private/corporate schools have to do trade-off between 'infrastructure, qualification and experience of teachers' and 'the total Fee'.

The above conflict clearly put forth's that same strategic decision may not work for all the schools because of the locations (as some are located at high income group location in Bombay, some are located at low income group). In addition to income the parent's education, mind-set, culture, other perceptions etc. affect the decision of parents to take admission in a school or not.

These trade-offs can be analyzed by a well established marketing research technique popularly known as conjoint analysis. The conjoint analysis was devised by Green and Srinivasan (1978) and has been used in various disciplines like psychology, economics and marketing. The conjoint analysis focuses on the quantitative description of consumer preferences or value trade -offs (Dijkstra et al 1996) and helps practicing mangers in decision making. As the conjoint analysis is a best technique to arrive at tradeoff between attribute which is preferable for both consumer (Parents) as well as producer (School Management), in case of present study the conjoint analysis will help the school management to deal with the problems related to explanation of customer (Parents of school-going children) preferences for different attributes at different levels that describe the product/process,).

2. Theoretical Background

Conjoint analysis is developed in early seventies and over a period of time it found it application in different sectors (academic and Industry) extensively (Green and Rao 1971; Johnson 1974; Srinivasan and shocker 1973b). In early 80's after the popularity of conjoint analysis, about 400 commercial applications were carried out (Wittink and Cattin, 1989). The reason behind extensive usage of conjoin analysis was the, introduction of microcomputer packages in early 80's. In conjoint analysis one estimates the preference attributes in which respondent give overall evaluation to a set of attributes. Srinivasan (1982) included price as one of the attribute as it is critical, when it comes to take decision to buy or not to buy a product. Conjoint analysis gives better results when it can be performed at individual level rather than at aggregate or segment level (Wittink and Montgomery 1979; Louviere and Woodworth 1983; Moore 1980).

Gensch (1987) in his study has emphasized that one has to exclude methods of perception survey data. When data is collected under fractional factorial design and multiple regressions is used for estimation procedure, and then one has to choose the model which is having probability of high predictive validity (Cattin and Punj 1984; Hagerty 1985). Conjoint studies carried out to estimate main effects. In some cases two-way interaction effects are important (Carmone and Green 1981). Conjoint predictive validity in non-compensatory environment may be poor (Huber 1987, Johnson, Meyer and Godse 1989). There are methods for constructing treatment sets for conjoint analysis, which are Pareto optimal (Krieger and Green 1988). Empirical results of whether Pareto-optimal design provides greater predictive validity than standard orthogonal design, the results are mixed (Hubber and Hansen 1986, Green, Helsen and Shandler 1988). The studies by Moore and Holbrook (1990), Elord, Louviere and Davey supported the findings of Green, Helsen and Shandler (1988).

Using ranking and rankings data, the relative importance of a parameter/attribute increase as the number of levels increases, while minimum and maximum values for parameter are fixed (Wittink, Krishnamurthi and Nutter 1982, Wittink, Krishnamurthi and Reibstein 1990). While rating and ranking, the paired comparisons are ordinary method (computer assisted) of data collection, such as Adaptive Conjoint Analysis (Johnson 1987).

Srinivasan, Jain and Malhotra (1983) recommend restricted attribute estimation approach to advance predictive validity. Other authors proposed full –profile conjoint analysis (Hagerty 1985 and Kamakura 1988). Some of conjoint analysis studies have been used to provide a discrete- level analog to response surface modeling (Markowitz, Stanley and Chandler, 1977). Individual based conjoint analysis may be difficult to improve significantly (Cattin, Gelfand and Danes 1983). Predictive capability at individual level may be misplaced (Hagerty, 1986).

When it comes to handle large number of attributes full profile method extended through "bridging" designs (Johnson 1976). A simple full profile method can be used for fewer attributes. But in Industrial setting when number of attributes are large the conjoin analysis is strained by putting overload on respondents (process owners), which may distort the preference structure (Wright 1975). Remaining part of the paper includes objectives of the study, followed by methodology adopted, which is further adopted by conclusion and discussion followed by limitations and future scope.

3. Methodology

The following eleven steps methodology has been used to develop perception mapping of parents for Strategic Decisions at two schools located in two different socio-economic environment and converted the same as case study based paper.

Step1: The Problem Statement
Step2: Objectives of Study
Step-3: Identification of attributes/factors to be studied for given problem w.r.t preferences of parents
Step-4: Identification of attribute/factor and factor levels to each factor
Step-5: Use Taguchi Design of Experimentation for designing the stimuli for experiment.
Step-6: Perform the training activities for all groups/samples (PTA members) to ensure quality and reliable data for each run of design
Step-7: Sampling design and data collection plan
Step-8: Pasting of collected data in Minitab worksheets for analyses
Step-9: Analyses of data and determination of factor worth of each Study Location.
Step-10: Calculation of parent's perception Index
Step-11: Interpretation of factor-worth/perception of parents and arriving strategic decision that is best for parents and school-management

3.1 Problem statement

Problem Statement: There is no mathematical models to take a decision on 'whether to increase the fees or not' and how much fees to increase and what additional value to be provided to students to maximize new admission-growth-rate. Hence the authors have decided to apply conjoint analysis for perception mapping of parents of a schools surrounding through experimental design for taking best strategic decision on various parameters of schools.

3.2 Objectives of the study

- To identify the school attributes/factors that are significant to school-going-children's parents
- To estimate each attribute worth with-respect-to a selected segment (Income, Culture etc..,) of parents
- To examine perception mapping of parents for strategic decisions of a school
- To maximize new Admission-Growth-Rate of a School by optimizing above mentioned attributes (AET, QT, Fee, and RoS) based on attribute/factor worth.

3.3 Identification of Attributes

In Conjoint analysis attributes are selected on the basis of past experiences, questionnaire survey, interviews. Only those features of salient attributes are chosen in which differences exists. As in this case author(s) intended to examine the optimal mix of attributes for strategic decision making from parents and school owner point of view. Subsequently conducting several discussions with school owners and parent teacher association (PTA) members, finally four critical attributes have been identified viz Qualification of Teachers (QT), Average Experience of Teachers (AET), Fee and other Expenses (Fee), Reputation of the School (RoS).

3.4 Identification of attributes and levels for each attribute

Every attribute may take different values and any process/product is a particular combination of attributes. In this study four attributes each at three levels were taken low, medium, high respectively as shown in Table 1.

Table 1 Attributes and Attribute Levels

Sr. No.	*Attributes*	*Notation*	*Unit of Measure*	*No. of levels*	*Actual Factor Levels*		
					Level 1	*Level 2*	*Level 3*
1	Qualification of Teachers	QT	%	3	Minimum Required Qualification (MRQ)	Moderately high (MH)	High (H)
2	Average Experience of Teachers	AET	Years	3	Low	Medium	High
3	Fee and other Expenses	Fee	Rupees	3	Low	Medium	High
4	Reputation of the School	RoS	100 Point Scale	3	Low	Medium	High

3.5 Use Fractional Factorial Design of Experiment

In Conjoint Analysis the profile of different products/process are presented to the consumers for their responses. These shapes are generated by varying the levels of its attributes. For example, suppose we are conducting a Conjoint Analysis based study of dish washers. Let us assume that the most important attributes considered by its customers are (w, x, y, z) Let us further assume that the following levels of attributes are considered relevant and interesting by the marketer for the study: Since the 4 attributes can take 3 levels, the total number of possible combination that can be generated by configuring these attributes is 3*3*3*3= 81. For determining the part worth utilities of each of the levels, of all these attributes, authors (s) have to take 81 different combinations for getting his response.

However this number is certainly too large for any consumer. Therefore, author has used Taguchi experimental design method which helps to minimum number of experiments that are necessary to use in the study. These designs are also mutually independent (orthogonal) to avoid any redundancy in the data and allow the representation of each of the attributes and their respective levels in an unbiased manner.

As in above mentioned case author(s) has taken L9 experiment by considering certain assumptions like each attributes is considered to be independent of each other, none attributes interact among themselves. For Location 1 and Location 2 five (R1,R2,R3,R4,R5) experts and seven(R1,R2,R3,R4,R5,R6,R7) experts from PTA were taken respectively. Further the

experimental designs for both L1 and L2 have generated with the help of Minitab software as shown in Table 2 and Table 3 respectively.

Table 2 Taguchi design for Location 1

Sr.No	QT	AET	FEE	RoS	R1	R2	R3	R4	R5
1	MRQ	L	L	L					
2	MRQ	M	M	M					
3	MRQ	H	H	H					
4	MH	L	M	H					
5	MH	M	H	L					
6	MH	H	L	M					
7	H	L	H	M					
8	H	M	L	H					
9	H	H	M	L					

Table 3 Taguchi design for Location 2

Sr.No	QT	AET	FEE	RoS	R1	R2	R3	R4	R5	R6	R7
1	MRQ	L	L	L							
2	MRQ	M	M	M							
3	MRQ	H	H	H							
4	MH	L	M	H							
5	MH	M	H	L							
6	MH	H	L	M							
7	H	L	H	M							
8	H	M	L	H							
9	H	H	M	L							

After selecting the nine combinations with the help of Taguchi design which are required for the ConjointAnalysis study, they need to be exposed to the respondents as stimuli. Generally this is done as per the requirement of the researcher and demands of the situation. In this study author has identified seven schools as per design and two were assumed as prototype. Here author has considered two (L1 and L2) community location, where L1 corresponds to PTA member's response belongs to economically backward society schools, where L2 corresponds to PTA member's response belongs to economically strong society schools.

3.6 Perform the training activities for all groups/samples.

One of the authors is principal of the school, she identified six schools in Mumbai which are fitted in six different runs of above design i.e. run number 2, 3, 4, 5, 7, 9 and three virtual schools created as per run number 1, 6 and 8 shown in design. The virtual schools creation is because the author was not getting the schools similar to design 1, 6 and 8. Finally the author set the real and virtual schools in-order, before collecting ratting data from a selected qualifies and trained PTA members who are truly represented sample of location 1 segment (low income parents).

The author had conducted training to selected qualified PTA members to evaluate the real & virtual schools in design for ensuring minimum measurement error within the sample member and among sample member.

3.7 Sampling design and data collection plan

The author had planned different days to visit different designed schools as per the design run along with the selected & trained sample PTA members to show the school with

respect to various parameters before rating in 100 point scale to each run of design. As per above plan the ratings data has collected for two different school strategic decision with two different segment of trained PTA members from two different school locations.

3.8 Data Collection

Data collection is important phase of conjoint analysis. In this study the PTA members are respondents for L1 and L2 are asked to rate the combination of attributes on 100 point scales. Here PTA experts for L1 (R1, R2, R3, R4, R5) and PTA experts for L2 (R1, R2, R3, R4, R5, R6, R7) attributes jointly not separately, which is shown in Table 4 and Table 5 respectively.
The author has used Taguchi design to increase the growth rate of school at two different locations with the help Conjoint Analysis.

Table 4 Rating of PTA experts for Location 1

Sr.No	QT	AET	FEE	RoS	R1	R2	R3	R4	R5
1	MRQ	L	L	L	59	58	60	61	62
2	MRQ	M	M	M	58	57	58	59	58
3	MRQ	H	H	H	59	60	58	57	58
4	MH	L	M	H	63	65	64	64	65
5	MH	M	H	L	41	42	40	39	38
6	MH	H	L	M	75	74	74	75	73
7	H	L	H	M	47	47	48	49	48
8	H	M	L	H	79	81	80	82	79
9	H	H	M	L	54	55	55	56	56

Table 5 Rating of PTA experts for Location 2

Sr.No	QT	AET	FEE	RoS	R1	R2	R3	R4	R5	R6	R7
1	MRQ	L	L	L	18	17	19	20	22	23	20
2	MRQ	M	M	M	39	41	40	39	40	39	38
3	MRQ	H	H	H	64	63	62	63	65	63	64
4	MH	L	M	H	53	54	55	53	51	52	52
5	MH	M	H	L	32	31	30	30	29	28	30
6	MH	H	L	M	61	60	60	61	59	62	61
7	H	L	H	M	45	45	46	44	45	45	44
8	H	M	L	H	70	70	69	70	71	71	69
9	H	H	M	L	52	53	54	53	55	54	53

3.9 Determination of part worth utilities

In below Table 6 part worth utilities are calculated for first factor QT at Minimum Required Qualification, Moderately High and High and rest three factors AET, Fee and ROS all at Low, Medium, and High. In first row QT is ranked w.r.t (MRQ, MH, H) levels at 100 point scale by five PTA experts (i.e. MRQ:- 60, 58, 58, MH:- 64, 40, 74, H:- 48, 80, 55) from above table. In next column the average rank at all levels of QT, calculated by taking average i.e. MRQ = (60+58+58)/3=58.67. Part worth = (61.00-58.67) = 2.33.

Estimated part worth is calculated by subtracting minimum from higher value of average rank level and factor importance is calculated with help of estimated part worth (e.g for QT (2.33/45.67) x 100)=5.10. Similarly for other 3 factors (AET, FEE, ROS) part worth and factor importance is calculated as shown in Table 6.

Table 6 Part worth utility for Location 1

Average Ranks and Deviations for Location 1					
Name of the Factor	Factor Levels per Attribute	100 POINT SCALE	Average Rank of Level	Estimated Part worth	Factor Importance (%)
Qualification of Teachers	MRQ MH H	60,58,58 64,40,74 48,80,55	58.67 59.33 61.00*	2.33	5.10
Average Experience of Teacher	L M H	60,64,48 58,40,80 58,74,55	57.33 59.33 62.33*	5.00	10.94
Fee	L M H	60,74,80 58,64,55 58,40,48	71.33* 59.00 48.67	22.67	49.63
Resource and Reputation of School	L M H	60,40,55 58,74,48 58,64,80	51.67 60.00 67.33*	15.67	34.31

*represents optimal level

In below mentioned Table 7 part worth utilities are calculated for first factor QT at Minimum Required Qualification, Moderately High and High and rest three factors AET, FEE and ROS all at Low, Medium, and High. In first row QT is ranked w.r.t (MRQ, MH, H) levels at 100 point scale (i.e. MRQ: - 20, 29, 63, MH: - 53, 30, 61, H: - 45, 70, 53) from above table. In next column the average rank at all levels of QT, calculated by taking average i.e. LOW= (20+39+63)/3=40.67.

Estimated part worth is calculated by subtracting minimum from higher value of average rank level and factor importance is calculated with help of estimated part worth (e.g for PQT (15.33/67) x 100=22.88). Similarly for other 3 factors (AET, FEE, ROS) part worth and factor importance is calculated as shown in Table 5

Further relative significance of attributes for L1 has been calculated with the help of ANOVA as shown in Table 6.The results shows that QT, AET, Fee and RoS having p value less than 0.05 which means these attributes have significance effect on the growth of school for Location 1.Similarly for Location 2 ANOVA is calculated, here also all four factors viz. QT, AET, Fee and RoS significantly effecting the growth of school as shown in Table 9.

3.10 Calculation of parent perception index

The parent's perception index has been calculated by using the following mathematical formula

$$PI= \mu+ F_{pwg1}+ F_{pwg2}+ F_{pwg3}+ F_{pwg4}$$

Where PI= parents perception index (higher the better)

μ= average rating of PTA members for nine experiments.

Part worth gain = average rating of optimal level of a factor - μ

Perception Index at optimal for L1 as shown below

F_{pwg1}= part worth gain of factor 1 (QT) with optimal setting (61-59.67 = 1.33)

F_{pwg2}= part worth gain of factor 2 (AET) with optimal setting (62.33-59.67 = 2.66)

F_{pwg3}= part worth gain of factor 3 (Fee) with optimal setting (71.33-59.67 = 11.66)

F_{pwg4}= part worth gain of factor 4 (RoS) with optimal setting (67.33-59.67 = 7.66)

PI (L1) = 59.67+1.33+2.66+11.66+7.66=83.00

Similarly Perception Index at optimal for L2 has been calculated
PI (L2) = 48.22+7.78+10.78+2.11+13.78 =82.67

Table 7 Part worth utility for Location 2

Average Ranks and Deviations for Location 2					
Name of the Factor	Factor Level per Attribute	100 POINT SCALE	Average Rank of Level	Estimated Part worth	Factor Importance (%)
Qualification of Teachers	MRQ MH H	20,39,63 53,30,61 45,70,53	40.67 48.00 56.00*	15.33	22.88
Average Experience of Teacher	L M H	20,53,45 39,30,70 63,61,53	39.33 46.33 59.00*	19.67	29.36
Fee	L M H	20,61,70 39,53,53 63,30,45	50.33* 48.33 46.00	4.33	6.46
Resource and Reputation of School	L M H	20,30,53 39,61,45 63,53,70	34.33 48.33 62.00*	27.67	41.30

*represents optimal level

Table 8ANOVA calculation for Location 1

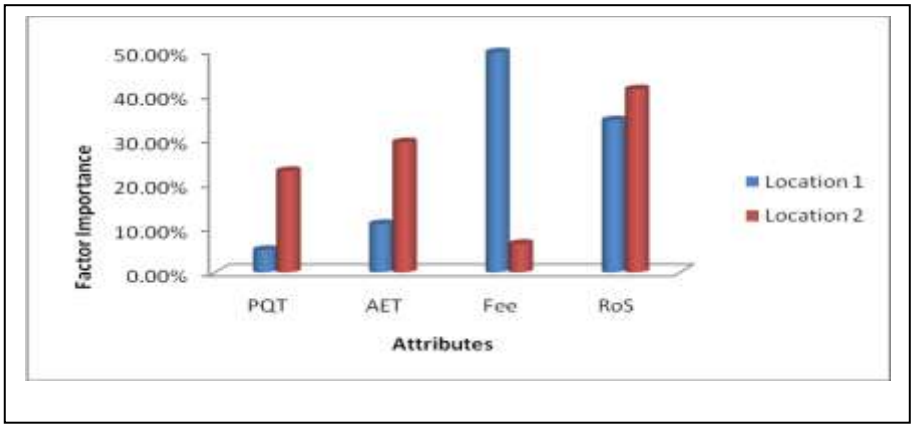
ANOVA using adjusted SS for tests						
Source	**DF**	**Seq. S.S**	**Adj. SS**	**Adj.MS**	**F**	**P**
QT	2	40.71	40.71	20.36	16.21	0.000
AET	2	211.24	211.24	105.62	84.12	0.000
Fee	2	3885.38	3885.38	1942.69	1547.27	0.000
RoS	2	1889.24	1889.24	944.62	752.35	0.000
Error	36	45.20	45.20	1.26		
Total	44	6071.78				
S = 1.12052 R-Sq = 99.26% R-Sq(adj) = 99.09%						

Table 9ANOVA Calculation for Location 2

ANOVA using adjusted SS for tests						
Source	DF	Seq. S.S	Adj. SS	Adj.MS	F	P
QT	2	2429.6	2429.6	1214.8	847.21	0.000
AET	2	4281.4	4281.4	2140.7	1492.95	0.000
Fee	2	174.9	174.9	87.4	60.99	0.000
RoS	2	8037.2	8037.2	4018.6	2802.63	0.000
Error	54	77.4	77.4	1.4		
Total	62	15000.4				
S = 1.19744 R-Sq = 99.48% R-Sq(adj) = 99.1%						

Table 10 Comparison of L1 vs L2

Attributes	Location 1	Ranking (L1)	Location 2	Ranking (L2)
QT	5.10%	4	22.88%	3
AET	10.94%	3	29.36%	2
Fee	49.63%	1	6.46%	4
RoS	34.31%	2	41.30%	1



After comparing Location 1 (Economically backward society schools) and Location 2 (Economically advance society schools) it shows that Fee is most important in L1 where as in L2 the RoS is most important, similarly other attributes may be interpreted.

Table 11 Attributes Preference for Location-1; and Location-2

Attributes	Location 1 1 (Preferences)	Location 2 2 (Preferences)
QT	MRQ	H
AET	L	H
Fee	L	H
RoS	H	H

Hence author has suggested that school in location L1 and L2 should be operated the attribute to maximize the growth rate as shown in Table 11.
By operating at this level parents' perception Index for L1 83.00 and for L2 is 82.67 can be maintained. Authors have suggested two different operating strategies as mentioned above for two different locations of schools.

4. Discussions and Conclusion

The ANOVA results in Table-7 and Table-8 showed that the parent perception index is affected 99% confidence level with four factors viz. Qualification of Teachers (QT), Average Experience of Teachers (AET), Fee and other Expenses (Fee), Reputation of the School (RoS) for schools located at L1 and L2. In the case of L1 the part worth of QT is 2.33, AET is 5.00, Fee is 22.67, and RoS is 15.67. Similarly L2 the part worth of QT is 15.33, AET is 19.67, Fee is 4.33, and RoS is 27.67. Based on the above part worth the most important factor for the school located at L1 is Fee the second most important factor is RoS the third and fourth ranked factors are AET and QT respectively. In the case of school located at L2 the most important factor is RoS the second most important factor is AET the third and fourth ranked factors are QT and Fee respectively.

Based on the above ranking of factors for L1 and L2 the following strategies are recommended for schools located at L1 and L2:

Recommended strategy for School located at Location 1: schools should be operated with 'Minimum Qualified teachers', select 'Low Experienced Teachers', 'Low Fee' and provide High resources for High Reputation to ensure the parents perception index around 83.00 which ensures high new admission growth rate.

Recommended strategy for School located at Location 2: schools should be operated with 'Highly Qualified teachers', 'Highly Experienced teachers', 'High Fee' and provide High resource for High Reputation to ensure the parents perception index around 82.70 which ensures high new admission growth rate.

5. Limitation and Future Scope

The major limitation of the study is identifying/developing real schools as per experimental design hence the authors have used virtual schools for some of the experimental treatments. The cost and time is another limitation for conducting training to all the PTA members hence the authors have selected only five PTA members for L1 and seven PTA members for L2 for ranking the schools and the virtual schools as per design. There is a large scope to conduct further studies for different segments of schools that are segmented based on socio economic criteria. Also there is large scope to identify the further factors that are affecting new admission growth rate of the schools and incorporating in conjoint analysis for further optimization.

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