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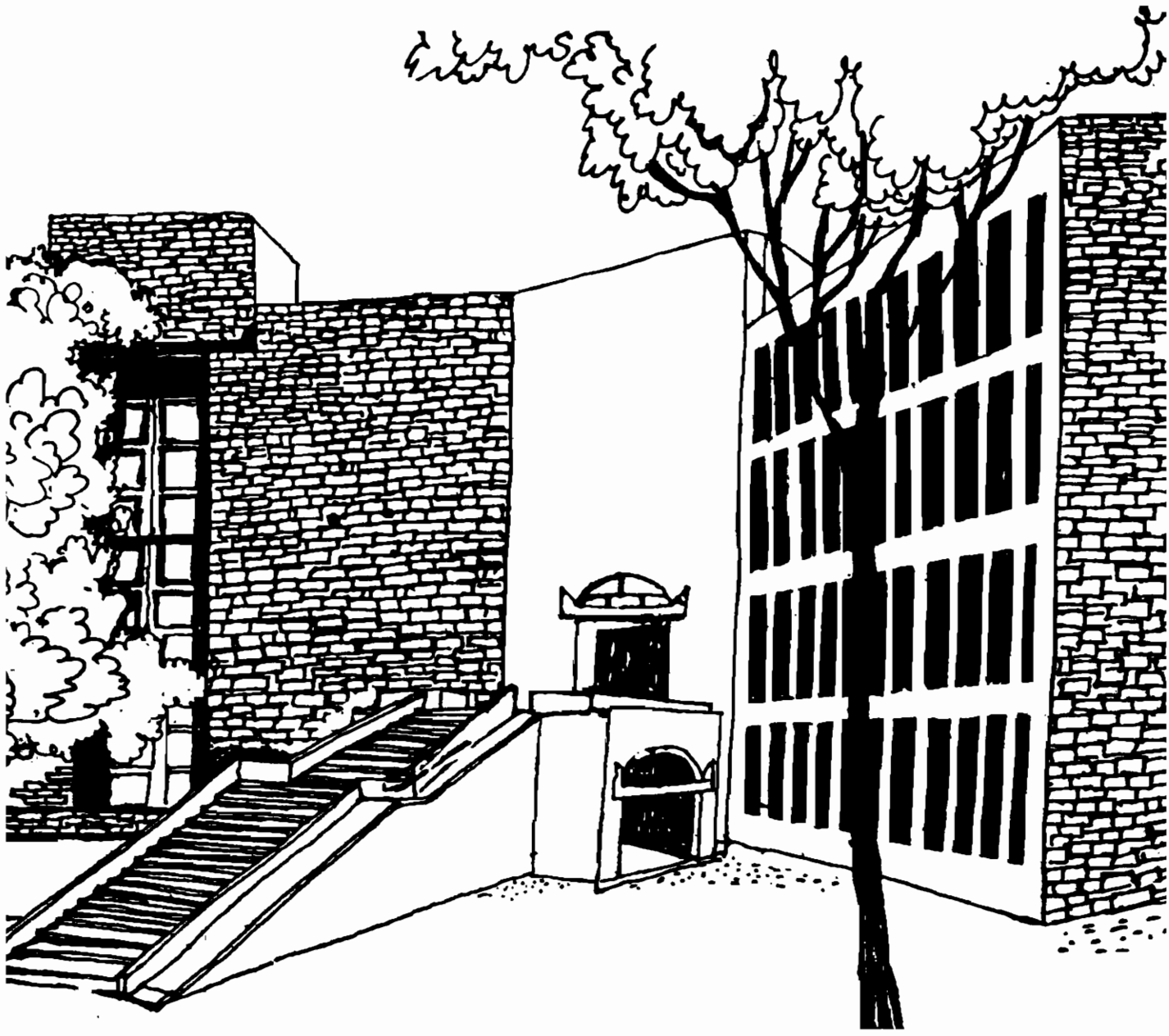

CHOOSING PRODUCT FEATURES THROUGH USERS RESPONSE: SOLAR COOKERS

By

Girja Sharan
Gopal Naik

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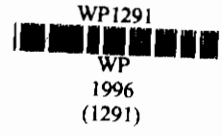

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INDIA

Choosing Product Features through Users Response: Solar Cookers

Girja Sharan Gopal Naik

Centre for Management in Agriculture
Indian Institute of Management, Ahmedabad

Introduction

Box solar cookers (cookers for short) were introduced in Gujarat about the year 1979. **Table 1** and **figure 1** show the diffusion data. Sharan [1] used the Bass equation to describe the diffusion pattern. Appropriateness of Bass equation to describe the cooker's diffusion process is only a hypothesis. When first developed, it was used to describe the diffusion of a number of consumer durables in the US. Since then it has been used for many more products and other markets. The resulting equation for cookers in Gujarat is given below.

$$N(t) = \frac{53700(1 - e^{-0.2t})}{1 + 10.3e^{-0.2t}}$$

where N number of cooker owners

t time (years since introduction, 1979)

It indicates the saturation limi to be only about 54000 units. This is low and indicates the need for product improvement. With a view to identify factors that may enhance the acceptance of cookers, a small survey of cooker owners and knowledgeable non-owners in Ahmedabad was conducted. The responses were put through conjoint analysis. Results presented in this paper are a part of that work.

Data

Addresses of the cooker owners was obtained from the manufacturers and other cooker owners. Fifty owners in and around Ahmedabad were selected. Another fifty households were selected who do not own cookers but are aware of it. Data was collected by home visit and interviews.

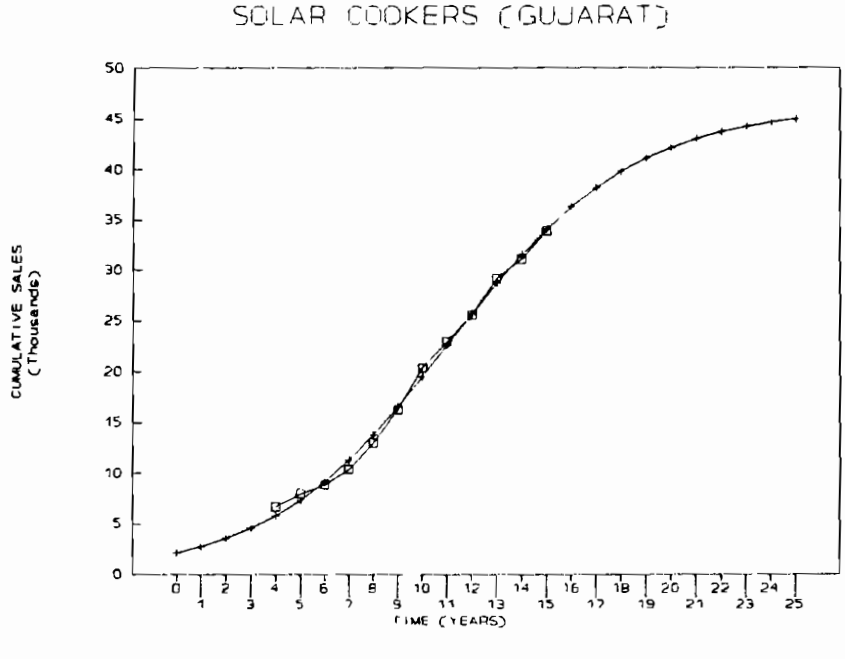
Profile of Users

Typically the owners h· l monthly income upwards of Rs.3000/- and family size of five. About one third (30%) housewives in sample were working women. Cookers were placed in terraces (58%) and balcony (26%). Most owners used the cooker once a day. Some (20%) used the cookers for as long as 7-9 months a year, but more often (44%) it was 4-6 months.

Table 1
Sale of Solar Cookers (Gujarat)

Year	Sale (no.)	Cumulative (no.)
1979-83	--	6725
1983-84	1294	8019
1984-85	856	8875
1985-86	1510	10385
1986-87	2566	12951
1987-88	3334	16285
1988-89	4101	20386
1989-90	2559	22945
1990-91	2666	25611
1991-92	3544	29155
1992-93	1898	31053
1993-94	2827	33880

Figure 1



Food Items

Users normally had bread, *dosa*, *idli*, *sambar*, porridge, *paratha*, *puri*, *poha*, *upma*, tea and milk for breakfast. Out of these the cooker could handle *dhokla*, *idli*, porridge, *muthia and sambar*. Users did some of the breakfast items the previous day. On the whole, the use of cooker in breakfast was limited.

Users commonly had rice, *dal*, *chapati*, vegetables, *khichdi*, *bakhri*, *dhokla*, *kadi* and *kheer* for lunch and dinner. Of these, the cooker could handle *dal*, rice and vegetable curry. *Dal*, rice, *khichdi*, *kheer* and *handva* done in cookers tasted comparatively better, but not the vegetables.

Methodology

Preference of users for attributes of cookers was assessed through conjoint analysis. Conjoint analysis gives the utility users associate with each factor and level [2]. Briefly the steps are as follows.

First, the independent attributes of cooker (or factors) are identified based on literature and discussion with some users and designer. For each attribute, levels that may be important to users and feasible in design are determined. Using this, the total number of different product feature options can be determined. Usually this number is too large to handle. A smaller, more convenient number of product-options capable of uncovering main as well as a first order interaction effects of each level can be obtained using Fractional Factorial Design (FFD).

Rank preference of these product-options are obtained from a sample of households. These preferences can be analysed using techniques such as monotonic analysis of variance or simple dummy variable regression to obtain weights for various levels of the attributes. The weights indicate the importance of the levels of the attributes and can be useful to design engineers in selecting the future design.

The attributes and the levels used in this study are shown in **table 2**. These are price (three levels), vessel material (two), weight (two), time (two), cooking indicator (two), back-up provision (two) and warranty (two).

Table 2
Factors and their Levels

S.No.	Factor	Levels
1	Price	1 = Rs. 600 2 = Rs. 900 3 = Rs. 1200
2	Material of vessels	1 = Aluminum 2 = Stainless Steel
3	Weight	1 = 8 Kg. 2 = 10 Kg.
4	Cooking Time (Dal in Summer)	1 = 2 Hours 2 = 3 Hours
5	Doneness Indicator	1 = Without 2 = With
6	Back-up Energy Source	1 = No 2 = Yes
7	Warranty	1 = No 2 = 1 to 3 Years

Table 3
Product Options Selected through Fractional Factorial Design

Product Option	Price	Material of vessels	Weight (kg)	Cooking Time (hrs)	Doneness Indicator	Back-up source	Warranty (years)
1	600	Aluminum	8	2	Without	No	No
2	600	Stainless Steel	8	3	With	Yes	No
3	600	Stainless Steel	10	2	With	Yes	1 - 3
4	600	Aluminum	10	3	Without	No	1 - 3
5	900	Aluminum	8	3	With	No	1 - 3
6	900	Stainless Steel	8	2	Without	Yes	1 - 3
7	900	Stainless Steel	10	3	Without	Yes	No
8	900	Aluminum	10	2	With	No	No
9	1200	Aluminum	10	2	With	Yes	No
10	1200	Stainless Steel	10	3	Without	No	No
11	1200	Stainless Steel	8	2	Without	No	1 - 3
12	1200	Aluminum	8	3	With	Yes	1 - 3
13	900	Aluminum	10	3	Without	Yes	1 - 3
14	900	Stainless Steel	10	2	With	No	1 - 3
15	900	Stainless Steel	8	3	With	No	No
16	900	Aluminum	8	2	Without	Yes	No

In an earlier study [3] it was found that price was not a major factor in urban areas. Therefore, a fairly wide range, Rs 600, Rs 900 and Rs 1200, was selected. Material of vessels was also of interest as some users did not like to cook in aluminum vessels. However, time taken to cook in aluminum vessels is less than in stainless steel vessel. Therefore, both these (time and material) are considered as two levels of the product feature.

Weight has been a common complaint reported in the earlier studies [3,4]. Therefore two levels of weights are considered 8 kg and 10 kg. Time taken for cooking has two dimensions: one is waiting time and the other is food not getting cooked when insolation is low. Therefore, this feature with possibility of about 50 per cent reduction in cooking time is included in the study.

While the possibility of food getting overdone is remote, when different food items are placed simultaneously, cooking indicator can help indicate which item is ready. This can avoid opening glass cover to check doneness, which causes heat loss. Cookers with a back-up source was also considered. This enhances the dependability of the cooker. In earlier studies certain common repair and maintenance problems were also mentioned. Therefore a warranty option was included.

With the above factors and levels a total of 192 product options are possible. Ranking of 192 product options by an individual respondent is very difficult. Fractional Factorial Design (FFD) was used to isolate individual factor, level effects and their first order interaction effects. This reduced the options to a more manageable number, 16 (**table 3**).

Each option was written on a card. Sample cards used for the first four product options are shown in **exhibit 1**. In accordance with the multiple-factor evaluation procedure, respondents were first asked to group the 16 cards into three more or less uniform groups, most preferred, least preferred and those lying in between the two. They were then asked to rank product options in each one of the three groups beginning with the most preferred group. Based on this two-stage process, a complete ranking of 16 cards was obtained. Although this data is on ordinal scale, it has been assumed in analysis to be on interval scale. This was done to simplify the task.

The ranks obtained for each respondents is subjected to dummy variable regression to estimate the weights of individual level of each factor as follows.

$$R = w_0 + w_{11}D_{11} + w_{12}D_{12} + w_2D_2 + w_3D_3 + w_4D_4 + w_5D_5 + w_6D_6 + w_7D_7$$

where R is the rank, w is the weight and Ds are dummy variables. The value of dummy variables are as follows

D_{11} = 1, if price is 900
= 0, otherwise

D_{12} = 1, if price is 1200
= 0, otherwise

D_2 = 1, if vessels are of stainless steel
= 0, if aluminum

D_3 = 1, if weight is 10 kg
= 0, if weight is 8 kg

D_4 = 1, time taken to cook dal is 3 hrs
= 0, time taken to cook dal is 2 hrs

D_5 = 1, if doneness indicator is provided
= 0, otherwise

D_6 = 1, if there is provision of using back-up source
= 0, otherwise

D_7 = 1, if warranty is provided for 1-3 years
= 0, no warranty is provided.

Two sets of samples were used--one consisting of owners, and other of non-owners who are aware and have knowledge about the cookers. Such non-owners were identified mainly on the references of the owners.

Users Preferences

Regression coefficients or the weights associated by the respondents to each of the eight product features (w0, w11, w12, w2 etc.) is given in table 4 for a few cases as an illustration. We shall summarise aspects of interest. The goodness of fit as indicated by R^2 (last column of tables 4A and 4B) is tallied in table 5. It is seen that for 88% of the present users and 78% of the knowledgeable non-users the R^2 was found to be greater than 0.65. It can be stated that the actual ranks assigned to the cookers of a given set of features, and the ranks predicted by dummy regression are close enough in most cases.

Table 6 shows the number of respondents for whom the indicated product features had significant weights. For instance, 26 of the 50 present users attach significant weightage to the

presence of back-up source. Similarly, 23 users attach significant weightage to the doneness indicator and 25 to the vessel material. The respective figures for non-users are back-up source (25), doneness indicator (28) and vessel material (23).

Thus, it can be stated that the preferences of the present users and knowledgeable non-users are similar. Among the eight product features the most popular are back-up source, doneness indicator, and vessel material.

Weight and time taken for cooking did not seem to be important features for many respondents. This could be because the levels chosen were not wide enough. Even the price is not significant for many respondents for both owners and non owners.

In order to examine the extent of additional acceptability of cooker simulation was done to estimate the ranks obtained with different features. It is assumed that any respondent having a rank below 9 will be assumed to be a potential purchaser. The summary of the simulation is shown in **table 7.** It is seen that only 14 out of 50 knowledgeable non-users will buy the cooker as it is now. If a back-up source is added the number of potential buyers will increase to 22. Fortysix out of 50 will buy a cooker with all the three features mentioned above.

Table 4A
Estimated Regression Coefficients for Individual Owner Respondent

Respondents	Constant	Price (900)	Price (1200)	Material of vessels	Weight	Cooking Time	Doneness Indicator	Back-up source	Warranty	R^2
1	10.50	2.50	2.00	2.00	0.00	-0.75	-1.75	-7.25*	0.25	0.76
2	12.00	0.25	2.50	-6.75*	1.00	0.50	-4.00*	1.00	-0.25	0.80
3	12.75	1.50*	1.00	-8.00*	0.50	1.00*	-4.00*	-0.50	0.50	0.98
:										
:										
50	12.75	1.50*	1.00	-8.00*	0.50	1.00**	-4.00*	-0.50	0.50	0.98

* Significant at 5 per cent level.
** Significant at 10 per cent level.

Table 4B
Estimated Regression Coefficients for Individual Non-Owner Respondent

	Constant	Price (900)	Price (1200)	Material of vessels	Weight	Cooking Time	Doneness Indicator	Back-up source	Warranty	R^2
1	16.38	-1.25	0.50	-7.25*	0.25	-0.50	-2.75**	-2.75**	-1.75	0.86
2	14.13	1.88	2.25	0.50	-1.00	0.75	-5.25*	-6.00*	-3.25*	0.93
3	10.88	-3.13	-4.75	1.75	-0.50	-0.50	1.00	-3.75	2.75	0.45
:										
:										
50	13.75	2.63	-0.25	-5.00*	2.25	-2.50	-3.75*	-3.00**	-1.00	0.80

* Significant at 5 per cent level.
** Significant at 10 per cent level.

Table 5
Goodness of Fit of Data

R^2	Users	Non users
Less then 0.5	2	5
0.5 to 0.65	4	6
0.65 to 0.8	11	10
Above 0.8	33	29

Table 6
Significance of Coefficients of the Product Features

Respondent Category	Significance Level	Price (900)	Price (1200)	Material of vessels	Weight	Cooking Time	Doneness Indicator	Back-up source	Warranty
Users	10%	12	12	25	16	9	23	26	18
	Positive	12	12	1	14	8	0	1	3
Non-users	10%	11	12	23	3	6	28	25	14
	Positive	8	9	0	7	0	0	0	0

Table 7
Simulated Number of Respondent Buying Solar Cooker with Different Features

Features	Non users	
	Number	Per cent
As it is	14	28
With backup source	22	42
With SS vessels	20	40
SS + backup	41	82
SS + backup + Doneness Indicator	46	92
SS + backup + Doneness Indicator + Rs 1200	20	40

Further, although pricing it at Rs.1200/- will deter some of these, the model will be more appealing that the present one. These corroborate some of the findings reported by Devdas [4]. Dependence on sun shine (alone), inability to judge the "doneness" were some of the factors reported by him which deter the adopters.

Conclusions

Design engineers constantly face the problem of deciding which of the several possible design features will appeal to the potential buyers the most. Conjoint analysis, appears to be a promising technique, as illustrated through a small sample exercise in this study.

Based on this exercise, it can be stated that features preferred are back-up provision, stainless steel vessels and "doneness" indicators.

Exhibit 1 : Sample Cards

Weight	8 Kg
Material	Stainless Steel
Back-up Source	No
Cooking Time (Dal in Summer)	2 Hrs
Doneness Indicator	No
Warranty	3 Yrs
Price	Rs 1200

Weight	8 Kg
Material	Aluminium
Back-up Source	Yes
Cooking Time (Dal in Summer)	3 Hrs
Doneness Indicator	Yes
Warranty	3 Yrs
Price	Rs 1200

Weight	10 Kg
Material	Stainless Steel
Back-up Source	No
Cooking Time (Dal in Summer)	3 Hrs
Doneness Indicator	No
Warranty	No
Price	Rs 1200

Weight	10 Kg
Material	Aluminium
Back-up Source	Yes
Cooking Time (Dal in Summer)	2 Hrs
Doneness Indicator	Yes
Warranty	No
Price	Rs 1200

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