ABSTRACT

The continued large-scale use of inefficient flame-based cookstoves directly influences human development levels globally, including in South Africa. It has been demonstrated that the adoption and sustained use of safe, inexpensive and improved stove designs by domestic households could lead to a significant reduction of household air pollution (HAP). From examination of descriptions of previous improved cookstove dissemination programmes, it becomes apparent that the focus on customer preferences was absent in many of the unsuccessful projects. Social marketing strategies with a customer focus have been widely applied (for more than three decades) in the fields of public health and the environment with significant success.

This paper investigates the customer preferences for improved flame-based cookstove features in two South African study areas using a willingness-to-pay survey methodology. The paper will suggest which combination of stove features (i.e. fuel types, sizes, durability and payment options) represent a necessary companion to other strategies in the dissemination of improved flame-based stoves in the South African market place.

Keywords: social marketing, household air pollution, HAP, improved stoves, willingness-to-pay, conjoint analysis, South Africa.

1. INTRODUCTION

Social marketing strategies aimed at replacing inefficient flame based cookstoves can play a major role in reducing Household Air Pollution (Barnes et al., 2011; Puzzolo et al., 2013). Key to a social marketing strategy is the identification of customer preferences, and, in the case of improved stove programmes, converting these preferences into viable stove features (MacFadyen et al., 2003; Lee & Kotler, 2011). The prevalent view of stove dissemination projects and household air pollution interventions, gleaned from academic literature, is that products usually emanate from either new knowledge or new combinations of existing knowledge about stove technologies, followed by product deployment in the field (Barnes et al., 1994; Schlag & Zuzarte, 2008; Cordes, 2011). By contrast, marketing literature suggests that successful product and services are the result of insights and ideas gleaned from customers (Tollin & Carù, 2008). Social marketing insights can also be found within existing cookstove markets (Håkansson et al., 2005). The features of a prospective improved stove need to integrate comfortably into the lives of customers. It has to make sense for them by providing real or perceived benefit in their daily living (London et al., 2010; Simanis, 2011).

The use of willingness-to-pay surveys is a fundamental part of marketing research, and can be used to estimate the willingness of customers to pay for and use stoves with specific features (Hensher et al., 2005). A conjoint analysis method is regarded as the most appropriate method for evaluating choices among a selection of stove features, especially where not all of the chosen attributes are available in all stoves (Hensher, 1994; Louviere et al., 2000).

The aim of this paper is to determine the features of improved flame-based cookstoves preferred by customers in South Africa that could contribute to the development of a successful stove dissemination strategy.

2. WILLINGNESS-TO-PAY METHODOLOGY

A willingness-to-pay methodology was used to evaluate the customer preferences for a variety of stove features, as suggested by Kuhfeld et al. (1994), Del Mistro & Hensher (2009) and Menegaki, (2012).

Central to the willingness-to-pay methodology is a Stated Preference (SP) survey technique. In the SP survey, the researcher asks respondents to choose between choices with stated attributes, using question card sets to determine the preference between different hypothetical cookstove combinations. The use of multiple questions, with different combinations of attributes, is considered more efficient than conventional questionnaires, because a large number of questions can be asked, thereby generating more than one sample from each respondent. The main cookstove features common to the South African market were used in the design of the choice experiments, presented to respondents as card-based question sets (Figure 1).
A conjoint analysis method was regarded as the most appropriate method for evaluating choices among a selection of attributes, especially where not all of the chosen attributes were available (Hensher, 1994; Louviere et al., 2000).

2.1 SITE & SAMPLE SELECTION

Representative households spanning the spectrum of prospective stove customers in urban and rural areas of South Africa were chosen, with the urban households selected from Mamelodi East and the rural households selected from the Sekhukhune District in Limpopo Province. The study consisted of a sample of fifty households in each of the sample urban and rural geographical areas. The households in the fieldwork samples were selected to capture various possible combinations of current income levels and energy use, the propensity for adoption of improved cooking stoves, the current reliance on traditional cooking methods and the availability of improved cooking stoves. The study sample was designed to be reflective of aspects of households’ circumstances, that may influence decisions to adopt or reject improved cooking stoves, rather than being representative of the actual pattern of adoption of the interventions in the geographical location. The sample households were expected to have low incomes and limited access to credit, i.e. similar to circumstances pertaining to the intended stove market.

The urban sample households in Mamelodi were selected from Mamelodi Phase 2, Mamelodi RDP Extension 18 and Mamelodi, Leeufontein. Situated on the eastern outskirts of Pretoria, Mamelodi covers a total area of 25 square kilometres, and has a population of close to one million (Stats SA, 2013). The dwellings range from informal dwellings made out of sheet metal, RDP houses constructed from cement bricks to well-built brick houses (Ligthelm, 2012; Mashigo, 2012; Cant et al., 2013).

The rural study sample was selected from the Sekhukhune District Municipality in Limpopo province. Households in Kotsiri, and Hlogotlou were selected to represent the specific rural characteristics of households living in traditional dwellings both with and without electricity access (Stats SA, 2013). The Sekhukhune District Municipality is a predominantly rural environment in the south with increased settlements and industrial and mining activities towards the north of the district (Stats SA, 2013). High levels of poverty, low levels of education and a high unemployment rate characterise the area. The use of biomass as fuel source is still prevalent despite the successful electrification of many households in the area (Stats SA, 2013).

2.2 CHOICE EXPERIMENT DESIGN: STOVE FEATURES AND ATTRIBUTES

The stove features were defined as those that were considered relevant to the customer. The unit of analysis used was the individual household, with the overall price benefits of the different stove alternatives being evaluated. A subset of profiles was then created to represent a variety of attribute levels.

The following stove features were selected:
- price level (Is the stove affordable stove?);
- product/brand (What type of stove by fuel type?);
- size of cooking stove (Does it need one cooking surface, instead of two?);
- durability (How long should the stove last?);
- finance options (If you can pay it off over three months, would you buy the stove?);
- safety options (After exposure to a “safer” version would you buy the stove?).

Each stove feature was then further categorised into different attributes. The range was limited because of the increased burden placed on the respondents. The following attributes were then defined for each candidate stove (Table 1).
Based on the selection of stove candidates, features and attributes, 162 possible product combinations were created (3 fuel types × 3 price combinations × 3 durability combinations × 3 size combinations × 2 micro finance variants = 162 combinations) that would constitute the full card matrix.

These card combinations were then adapted into twelve questions per respondent, with each question consisting of three cards randomly chosen from the set of 162 possible cards. Each combination of twelve questions constituted one choice set. Twenty-five choice sets were generated for 100 respondents. The twenty-five randomly generated choice sets were then tested on the four groups, each with twenty-five respondents (two randomly selected groups of respondents in Mamelodi, the one group with safety awareness information, while the other twenty-five were not given the safety information). Each of the four groups was presented with the twenty-five generated choice sets, with each respondent receiving one choice set comprising twelve questions. Each question set consisted of four cards, including the three cards with the generated stove features and attributes. Each of the twelve questions consisted of four options (three hypothetical stove selections and a “joker” card denoting the option if no preference is shown for the previous three stove choices) with the respondent choosing a single card. Each respondent therefore made twelve choices, with each choice representing the stove they would be willing to buy.

The choice sets were first tested, on a door-to-door basis, on fifty households in the Mamelodi study area (twenty-five with a safety awareness campaign included and twenty-five without). This was repeated in the Sekhukhune study area. The survey was conducted in English, and interpreted into Northern Sotho. After completing a consent form, respondents were given instructions for the survey while the researcher read them aloud. The instructions given to each respondent followed the same basic format. First, the introduction informed respondents that this was an experiment to see what they thought about various types of cookstoves and which ones they would like to purchase if they could. In all treatments, respondents were told that the cookstoves were not actually for sale, but were asked to answer the questions as if the survey options were real.

Following the introduction to the survey, a sample choice question was presented, after respondents had heard a clear explanation of the procedure for making choices between the four cards. Respondents were told they would answer twelve questions (just as for the sample question) but where the attributes of the stoves and their costs would vary. The choice sets of hypothetical stove attribute combinations were presented in the form of printed cards, with a photo of a real stove reflecting the hypothetical attributes. This approach allowed respondents to visualise the various choices and avoided potential confusion and fatigue (which can occur when respondents are asked a series of very similar questions). After presenting each card to the respondents, the cookstove and its attributes were described. Each respondent’s choice was recorded, with the chosen cards marked and filed with each consent form.

### Table 1 Stove feature attribute levels and fractions

<table>
<thead>
<tr>
<th>Stove Features</th>
<th>Attributes</th>
<th>Part Worth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Small</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>1</td>
</tr>
<tr>
<td>Durability</td>
<td>1 year</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>5 year</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>10 years</td>
<td>1</td>
</tr>
<tr>
<td>Safety</td>
<td>Without safety</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>With safety</td>
<td>1</td>
</tr>
<tr>
<td>Fuel Type</td>
<td>Biomass</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LPG</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paraffin</td>
<td></td>
</tr>
<tr>
<td>Financing</td>
<td>Cash</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>Lay-bye</td>
<td>1</td>
</tr>
<tr>
<td>Price</td>
<td>Low</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>1</td>
</tr>
</tbody>
</table>

Based on the selection of stove candidates, features and attributes, 162 possible product combinations were created (3 fuel types × 3 price combinations × 3 durability combinations × 3 size combinations × 2 micro finance variants = 162 combinations) that would constitute the full card matrix.

Images of existing cookstoves were used to characterise the choices embodied by each card set, and its individual features. An additional ‘joker’ card was added with each question to test for the eventuality of no choice meeting the respondent’s expectation.

### 2.3 SURVEY PROCEDURE

Respondents were asked to trade-off between the prices, fuel types, sizes, durability and payment options of hypothetical stoves. The fifty respondents in each sample area were split into two sub-groups (twenty-five respondents were presented with the safety awareness information, while the other twenty-five were not given the safety information). Each of the four groups was presented with the twenty-five generated choice sets, with each respondent receiving one choice set comprising twelve questions. Each question set consisted of four cards, including the three cards with the generated stove features and attributes. Each of the twelve questions consisted of four options (three hypothetical stove selections and a “joker” card denoting the option if no preference is shown for the previous three stove choices) with the respondent choosing a single card. Each respondent therefore made twelve choices, with each choice representing the stove they would be willing to buy.

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### 2.4 CHOICE ANALYSIS METHODOLOGY

The conjoint analysis de-constructed the card choices into components based on the attributes of the stove features (Breidert, 2006). A numerical part-worth utility value was computed for each level of each attribute. The part-worth utility ranges were then used to predict differing stove preferences (Breidert, 2006). The estimated regression coefficients associated with the attribute levels are the part-worth price values. The R^2 for the regression characterised the internal consistency of the respondent (Orme, 2010). A price lookup strategy was employed to map the price part-worth values to actual Rand-based price values that the respondents were able to view (Orme, 2010). Based on the choices made by the respondents, the preferences for the different products
were then estimated by using a fractional factorial design. The sample was separated out by stove type, with price being the dependent variable (y-axis) and the feature attributes (x-axis) were then plotted against it. The range of prices then gave a measure of price sensitivity for each given attribute and stove type. By separating the results of the two groups of respondents (i.e. those who received safety information and those who did not), a comparison could be made between the two sets of respondents. The data were then entered into a statistical model running in Microsoft Excel (Orme, 2010).

3. PRELIMINARY WILLINGNESS-TO-PAY RESULTS

The preliminary results are represented for the three selected stove technologies (biomass, LPG and paraffin) according to the various characteristics of size (pot size accommodated or number of plates–one, two or four), durability (one, five or ten years use) and available stove financing options. Each of these features was analysed by stove technology for the two sample areas. The results of the groups exposed to safety awareness information are excluded.

3.1 RELATIONSHIP BETWEEN PRICE AND SIZE

In general, it was observed that the size of the stove chosen affected the willingness to pay (price). The results of the conjoint analysis demonstrated that the size of the stove significantly affected the willingness-to-pay (Figure 2), with significant correlation taken as $R^2 > 0.7$. The results indicate that respondents are willing to pay for stoves that incorporate multiple cooking surfaces.

A marked difference in the maximum price respondents in Sekhukhune were willing to pay when compared with Mamelodi respondents was noted. Mamelodi residents were willing to pay up to R2 500 for a four plate LPG stove (Figure 2), while in Sekhukhune respondents were willing to pay a maximum of R1 500 for a multiple-plate biomass stove. As can be expected, Mamelodi, with its higher income levels, was less sensitive to price (higher slopes of correlation lines in Figure 2) than Sekhukhune. Significant correlations were found at $R^2 >0.70$ (Figure 2). The count of stoves chosen by size attribute (Figure 3) showed that a medium sized stove (two-plate) was the preferred option in both areas; fewer large stoves were chosen in Sekhukhune when compared with the choices by Mamelodi respondents.

1 The N-value was calculated for each of the two groups of respondents as follows: Each of the 25 respondents in each group made 12 choices, amounting to 300 choices made by each group. The joker cards (i.e. no stove choice meeting the respondents’ preference) were then subtracted, giving the final N-value for each of the two groups of respondents.
Sekhukhune respondents showed a preference for biomass stoves over LPG stoves, as anticipated because of the differences in income and the ready availability of no-cost fuel wood.

3.2 RELATIONSHIP BETWEEN PRICE AND DURABILITY

The conjoint analysis of the durability of the stove choices demonstrated the influence of the expected lifetime of the stove on the willingness of respondents to purchase a stove.

No significant correlation existed between durability and price in both areas, with respondents opting for the cheapest stove with adequate levels of durability (Figure 4). However, the count of stoves chosen (Figure 5) shows that the majority of respondents in both areas preferred the mid-range or better durability, inferring that respondents were willing to pay for quality.

No significant correlations were found for any of the stove choices related to durability. Respondents in Mamelodi showed a tendency to pay more for a less durable stove, being particularly sensitive to price over durability. In Sekhukhune, the strongest response was shown for mid-range durability at a lower price. Respondents in Sekhukhune were willing to pay more for a durable stove, but chose the lowest price for adequate quality, expecting the quality of the biomass and LPG stoves to be better than the quality of the paraffin stoves.

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2 The N-value was calculated for each of the four groups of respondents in as described in Footnote 1.
3.3 RELATIONSHIP BETWEEN PRICE AND FINANCE

The conjoint analysis of financing of the stove choices demonstrated the influence of two financing options of the stove on the willingness of respondents to purchase the stove.

For smaller low priced stoves, no observed preference was found (Figure 6). Once more expensive stoves were presented, a small bias – towards lay-by over cash – was found in both sample areas.

The preference for more expensive paraffin stoves demonstrated an increase among Sekhukhune residents when presented with a lay-by option (Figure 7). In Mamelodi, a preference for expensive stoves was seriously considered only when the availability of finance was offered, (confirmed by the card count in Figure 7).

3 The N-value was calculated for each of the four groups of respondents in as described in Footnote 1.

4. CONCLUSIONS

The overall results indicate a preference for larger stoves in both regions, which indicates the ability to cook with two pots simultaneously is an important attribute to consider. Furthermore, the availability of credit only became a factor for higher priced items, but did not seem to influence customer preferences to the degree expected. Respondents were willing to pay for adequate durability; thereafter they became price sensitive.
Figure 7  Preferences by stove technology and financing mechanism (Cash or Lay-by) (N=300 with twelve choices made for each of the twenty-five respondents)

5. BIBLIOGRAPHY


6. AUTHORS

Principal Author: Marcel Mare’s diverse work experience covers a wide spectrum of disciplines. It encompasses, concept design and innovation, advertising, interactive multimedia development, data visualization, project management and higher education. Marcel presently lectures in the field of multimedia, encompassing interaction design and brand design. The area of research is currently focused on the role of social marketing in the uptake of energy efficient stoves.

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