Integration of user behavior into cookstove design through utility functions and the Theory of Planned Behavior

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The Challenge of Adoption

Design with features that users value could help to alleviate low adoption rates (Mobarak et al., 2012).

Both the technology and promotion messages must improve so users perceive benefits of ICS to improve adoption in north India (Jeuland et al., 2015).

Low stove valuation by users prevented adoption and improvements in health or firewood consumption (Hanna, Duflo, and Greenstone, 2016).
Technology Design Process

Understand the Need

Research / Collect information

Test / Monitoring & Evaluation

Develop solutions / Analysis

Improve / Validation

➢ Understanding the User
- Demographics
- Focus groups
- Ethnography
- Qualitative data

Understanding the User
What Is Not Addressed?

Understanding the User

Quantitative Data Based on Beliefs and Personal Evaluations

- Understand the Need
- Research / Collect information
- Develop solutions / Analysis
- Test / Monitoring & Evaluation
- Improve / Validation

What Is Not Addressed?

Quantitative Data Based on Beliefs and Personal Evaluations

- Understanding the User
Practices in User Behavior Integration

Health Behavior Models
- The Health Belief Model
- Protection Motivation Theory
- Social Cognitive Theory
- Stage Theories of Health Behavior

Environmental Psychology Models
- Norm Activation Model
- Value-Belief-Norm Theory
- Goal Framing Theory
- Comprehensive Action Determination Model


Theory of Planned Behavior

- **Attitude Toward Behavior (ATB)**
  - Inhaling smoke emitted from cookstove is unhealthy.
  - People who are important to me use improved cookstoves.
  - It's too difficult for me to learn how to work with improved cookstove.

- **Social Pressure (SN)**

- **Perceived Behavior Control (PBC)**

- **Intention**
  - I am going to cook my principal meals with improved cookstove every day.

- **Behavior**
Decision-Based Design with TPB

- Technology design attributes (size, dimensions, weight, etc.)
- User Attributes (age, income, purchase history, etc.)
- Usage Context Attributes
- TPB attributes

\[ W_{in} = W(\beta; T_i, U_n, C_{i,n}) \]

More accurate prediction
Case study: ICS Design Analysis in Uganda

- Uganda
  - 175 households
  - Pilot, baseline, follow-up
  - ICS: ILF rural woodstove
  - Mobile surveying using Magpi®
### Results

**Utility estimation without TPB**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>No TPB attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>0.019*** (0.003)</td>
</tr>
<tr>
<td>Fuel type</td>
<td>-1.054*** (0.229)</td>
</tr>
<tr>
<td>Income</td>
<td>1 0.254 (0.403)</td>
</tr>
<tr>
<td></td>
<td>2 -0.243 (0.649)</td>
</tr>
<tr>
<td></td>
<td>3 0.102 (0.536)</td>
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</tbody>
</table>

- $\rho^2$ (%) = 21.55
- Hit rate (%) = 61.8
- Log-Likelihood = -187.81

**Utility estimation with TPB**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Interaction with TPB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>0.019*** (0.003)</td>
</tr>
<tr>
<td>Fuel type</td>
<td>-1.053*** (0.230)</td>
</tr>
<tr>
<td>Income</td>
<td>1 1.06 (0.716)</td>
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<tr>
<td></td>
<td>2 1.106 (0.716)</td>
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<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4 0.780* (0.443)</td>
</tr>
</tbody>
</table>

- $\rho^2$ (%) = 23.42
- Hit rate (%) = 61.8
- Log-Likelihood = -183.11

Robust standard errors in parenthesis. * p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01
Conclusions

- TPB attributes improve the prediction power of utility functions
- Designers could estimate market share of technologies based on users’ beliefs and behavioral characteristics
- Model works with relatively large sample sizes (rule of thumb more than 200 observations)
- Technology design and implementation strategies could be optimized for higher compatibility with users’ behaviors → Improves adoption rate
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Thank you for your time.

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