Can Urban User Testing Labs Evaluate Rural Solar Lighting Solutions?

A Pre-Pilot Study of User Centered Design

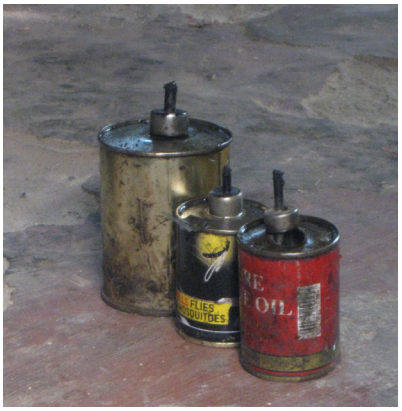
1: Solar lanterns have gained attention as alternatives to unreliable electrification and dangerous kerosene lamps, helping improve quality of life and productivity

Third brief in a series by the Rural Market Insight team at the Centre for Development Finance-IFMR that turns action research into learnable experience for those committed to the Base of the Pyramid.

Expanding their research, Rural Market Insight researchers from Centre for Development Finance-IFMR (CDF) conducted an eight-week study on the quality of user experience with D.light Design's low-cost Kiran solar lantern. Relevant design insights from the pre-pilot study with a Base of the Pyramid (BOP) household in Chennai, India lent further evidence to urban user testing labs for rural-targeted household energy products.

BACKGROUND

The solar lantern has gained international attention as a development tool that provides efficient, affordable lighting. In India, 56% of rural households (350 million people) still rely on kerosene as their primary lighting fuel. A growing number of companies have targeted Base-of-the-Pyramid (BoP) households that still depend on kerosene as potential customers willing to purchase solar lighting solutions. Initial research by CDF's Rural Market Insight team revealed that the quality of BoP users' experience with solar lanterns could play a determining role in generating market demand for off-grid energy.



2: Slow, unreliable electrification and subsidised kerosene have left India's BoP households with limited lighting options.

Moving Beyond PDS Kerosene in Rural India

Slow rates of rural electrification and dependency on kerosene have left India's BoP households with limited lighting options. Since the Second World War, the Government of India (GOI) has increasingly subsidized kerosene through the Public Distribution System (PDS). However, as much as 38% of PDS Kerosene is diverted, then sold at higher prices to intended beneficiaries according to governmental-sponsored study (IISD 2010). Four national efforts to reform

3: Several types of solar lanterns have arrived on India's small, but growing BoP solar lighting market.

the kerosene subsidy and reduce systemic corruption have faltered (ibid). In addition to being dangerously flammable, kerosene-fuelled fires contribute to Indoor Air Pollution (IAP), a leading cause of respiratory disease among poor women and children according to the World Health Organization (2005).

Since 2007, the solar lantern has gained recognition as an alternative to kerosene-wick candles. In 2010, the Ministry of New and Renewable Energy launched the Jawaharlal Nehru National Solar Mission (JNNSM) to meet India's growing energy demand by providing 20 million solar lighting systems to replace kerosene lighting in rural communities by 2022.

A market-based approach to distribution, as well as technological advancements in battery life, photovoltaic efficiency and Light-Emitting Diodes (LED), have opened a niche for private companies, investors and community organisations to offer BoP households and businesses a low-cost, off-grid lighting products. In 2010's report "Power to the People", CDF determined India's solar lantern market was worth INR 855 million (USD 18.58 million) per annum.

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-Dr. R.A. Mashelkar, President of Global Research Alliance

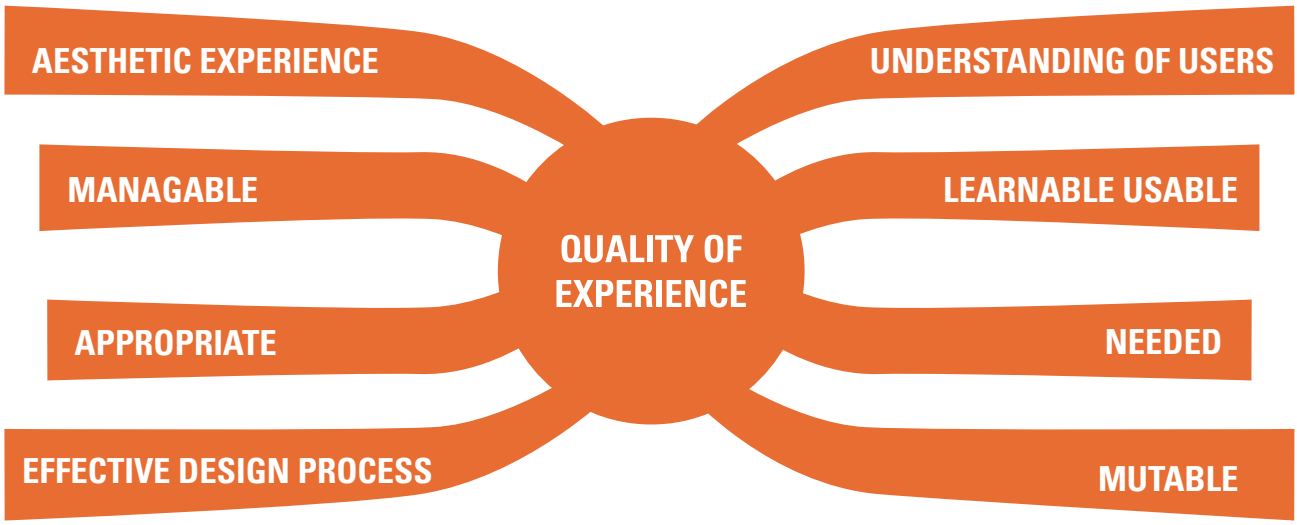
Understanding India's BoP Consumers

To ensure BoP consumer demand, companies offering solar lanterns and other rural-targeted energy solutions must understand the needs and wants that drive purchase decisions.

Creating off-grid energy products that drive BoP market demand requires deep understanding of the rural BoP user. "In this new paradigm of business," emphasized R.A. Mashelkar, former director general of Council of Scientific and Industrial Research, "we recognize that the poor will have the same functional and emotional experience as the rich have - but for a fraction of the price." BoP energy products must be not only affordable but high-performing and durable. Yet, extensive user testing in rural areas is challenging. Companies must locate rural test sites, identify households willing to test and provide user feedback, make multiple site visits to collect data and analyse insights, modify prototypes and repeat the process several times in several locations. Rural-targeted product companies need a robust, effective and efficient way to gain initial BoP user insights, while keeping costs low and design on schedule.

IDEA

In 2010, Rural Market Insight(RMI) conducted a user-centric test of the Kiran solar lantern by D.light Design. Drawing on RMI's previous research with urban user testing, the pre-pilot study's objective was to determine whether urban user testing could provide design insights for the solar lantern vertical of rural-targeted BoP household energy solutions. Can urban BoP user insights



4:The quality of experience concept (Alben 1996), originated for technology development, has been applied to understand BoP user experience.

into quality of user experience inform and help designers prioritise product design and development?

BoP User Testing in Urban Slums

Taking into account India's rising rural-to-urban migration, urban user testing targets BoP households that retain rural conditions and behaviours, such as lacking electricity and relying on kerosene. Of India's 56 million urban households, 7% rely on kerosene as their primary lighting fuel (National Sample Survey 61st round 2004-05).

Urban user testing economizes the limited resources for early-stage design testing of rural-targeted BoP household products. Urban slum areas provide a rich context of regional diversity and more frequent researcher-user interaction with minimal interruptions to the users' daily life. Urban poor who retain rural practices cannot only benefit from new technology, but also be involved in the design process. Urban areas also provide access to ample skilled resources needed for quick prototyping and modifications.

Discovering Quality of User Experience through UCD

A growing number of social entrepreneurs, research institutions and governments in India, China and many African countries have employed User-Centered Design (UCD) principles to design products for the world's BoP markets. UCD focuses on understanding the quality of the user experience for first-time product users. User needs, desires and challenges are discovered through 'deep listening' and 'deep dialogue' techniques. This informs product development companies on attributes that BoP end-users find valuable and desirable.

According to the "The Quality of Experience" framework by L. Alben (1996), a series of five research questions uncover key insights into user experience with the product:

- How does the product look and feel?
- Does the user understand how to use the product?
- How does the user feel while using the product?
- Does the product serve its purpose?
- How does the product fit into the user's environment?

Pre-pilot Methodology

With UCD principles, Rural Market Insight developed the hypothesis that urban user testing can uncover design insights for rural BoP products with five assumptions: 1) Urban households are willing and able to test products and provide relevant user-feedback; 2) User insights can be attained on a regular basis; 3) Select urban testers will use products similar to their rural counterparts; 4) User feedback will be similar to rural counterparts'; 5) Insights can be turned into design changes at a low cost.

5: Plan for Six-week study on Urban User Testing of Rural BoP Products

6: In contrast to kerosene candles placed on the floor, solar lanterns provide more light when hung

Several UCD methods were employed in this contextual study. Frequent semi-structured interviews in participants' native Tamil language, researchers elicited stories to draw out users' cognitive and subconscious reactions to the solar lantern. Direct observation focused on product use in the home.

ACTION

In January-February 2010, the hypothesis was tested in a three-step process: (i) Research (ii) Testing and (iii) Evaluation. Evaluation of the quality of the BoP user experience revealed key insights into product design and user education. The Kiran lantern was deployed in its box for free to a single family of five, living in a single household without electricity and who had no prior experience with solar lighting. The participant household was selected for its willingness to participate in the study and for having living conditions and family size similar to rural BoP households. They used approximately half a litre of kerosene to light four kerosene-wick candles for about 3 ½ hours each day. Instructions written on the box were explained in the family's native Tamil language.

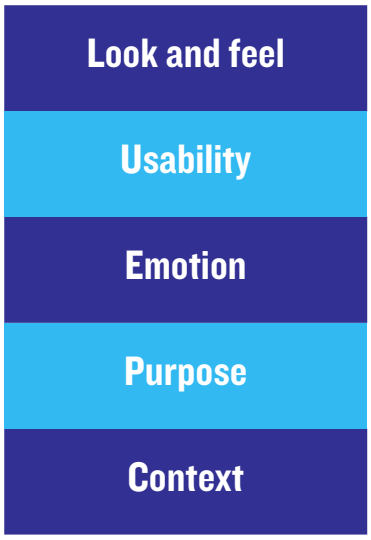
Product Profile

The Kiran, a household solar lantern manufactured by U.S.-based social enterprise D.light Design, is marketed as the lowest priced solar lantern on the Indian market, at INR 500. D.light has offered subsidized lanterns in India since 2008. End-users purchase lanterns with savings from not purchasing kerosene. D.light solar lanterns are most often used during cooking, studying, income-generating activities and household tasks.

Key Findings

At first, the participants were reluctant to replace their four kerosene candles. They initially placed the lantern on the floor, which limited the spread of light. After additional education and encouragement during the first week, they began to hang the lantern on a rope. It was used for three hours in the evenings. The Kiran solar lantern was most often used to light the sleeping area, and occasionally while cooking and to go to the outhouse. They reported that an hour-long break restored some of the lantern's brightness.

The solar lantern was set outside to charge for eight hours a day. Observation revealed that an elderly participant sat with the lantern while it charged to avoid theft. Interviews exposed that she felt that the lantern charged best under direct sunlight, but did not understand that the charging indicator gauged intensity of sunlight. On several occasions, the participants forgot to charge the lantern.



7: Feedback from the lantern user was evaluated on the five quality of experience frames

8: The look and feel of solar lantern differs greatly from traditional kerosene-wick candles

INSIGHT

User feedback with the Kiran solar lantern was evaluated on the five Quality of Experience frames (Alben1996).

1. How does the product look and feel?

Study participants found the Kiran solar lantern functional, portable and aesthetically pleasing. In contrast to BoP market research, participants did not mention the difference between the solar lantern's white light and kerosene candles' orange light. Yet, it took users two weeks to accommodate from the upward-facing light of their traditional sene-wick candles to the downward-facing light of the hanging solar lantern. After two months, the plastic top was cracked and dirt smudges were never cleaned

9: Without specific cleaning instructions, the users were unaware of how dust accumulation affected product performance

2. Does the user understand how to use the product?

Urban user testing revealed the importance of user education and instructions on product packaging. To maintain conditions similar to product purchase in rural areas, the researchers provided participants with the instructions on the Kiran's packaging. Without detailed explanation, study participants did not properly use certain product attributes like the brightness toggle switch and the multi-function handle for carrying and hanging.

Charging

Charging, a fundamental function of solar lanterns, was not well understood by the participants, who had no prior exposure to solar lighting. Without guidance on optimal charging, the primary user did not know when it had fully charged. Direct observation showed the lantern was often positioned with the charging indicator and company logo facing towards the sun, which made the lantern's solar panel face away from direct sunlight. Without specific cleaning instructions, the users were unaware of how dust accumulation affected product performance. The solar lantern was not cleaned during the study and dust accumulated over the solar panel, which could have affected the technology's ability to charge.

3. How does the user feel while using the product?

Quality of experience relies on the emotions the product evokes in the user. In this study, the participants reported initial frustration with the charging process and with dimness when the Kiran lantern sat on the floor. After three weeks of trial and error, the participants' satisfaction rose as they began to regularly charge the lantern and to hang it, allowing more light to be emitted.

Learning and Perceived Benefits

While the participants reported that the solar lantern was easy to operate, they also reported no perceived benefits over kerosene-wick candles. Furthermore, an elderly participant sat next to the lantern while it charged on the street, which made charging, typically a passive activity, an active, time-intensive task. This result is not found in lower-populated rural settings.

10: It took the users two weeks to accommodate from the upward-facing light of their traditional sene-wick candles to the downward-facing light of the hanging solar lantern

4. Does the product serve its intended purpose?

There is definite need for safe, reliable alternative lighting in urban BoP user settings. Without access to electricity in the participant household, the solar lantern solved a lighting deficit that was being met with four traditional kerosene-wick candles. After additional education about hanging the lantern, the solar lantern eventually replaced one candle used by the BoP household.

11: Charging became an active task for the participant who monitored against theft and shade

5. How does the product fit into the user environment?

Within two weeks, participants fully incorporated lantern use into their daily routines. Charging remained a time-consuming task for the participant who actively monitored it outside. The solar lantern was markedly safer than the open-flame, kerosene candles. However, users required additional education to prevent the plastic lantern melting near their open-fire cookstove [chulha]. Even at INR 500, the cost-benefit of the Kiran, the lowest priced solar lantern on the market, did not outweigh the lower cost and ample availability of PDS Kerosene for traditional wick candles.

Implications for BoP Product Companies

Urban UCD testing uncovered several insights of solar lantern use and provided strong evidence for further research. It highlighted the importance of user education and clean, intuitive design. Through short, frequent interactions, urban user testing revealed that specific BoP conditions shaped the quality of user experience. Intuitive use of various design attributes could enhance the quality of BoP user experience. Along with existing financing options, improved user experience could be worthwhile in the effort to drive solar lantern usage and demand in India's BoP markets. While it will always be necessary to conduct product testing with a rural target audience, urban testing can alleviate financial and logistical constraints that researchers face when conducting early-stage usability and design testing on BoP consumer energy products.

Key Design Attributes for the BoP User

Key design attributes affecting solar lantern usage in this BoP household involved ease of charging and adjusting brightness. Solar lantern design should facilitate effective charging so that the BoP user intuitively positions the lantern's solar panel towards the sun and clearly understands when the lantern is fully charged. Button functionality and instructions should be instructive so that the user turns the light to the off position before charging. Handles should facilitate hanging without damage to the plastic case.

Deepening Impact of Solar Lighting

In India's poor households, full electrification is still considered the ideal energy source because it provides constant current for lighting, cooking and charging mobile phones, radios and TVs. Its perceived challenges include cost of installation and maintenance, as well as power outages/power rationing. While PDS Kerosene is affordable and accessible, kerosene-wick candles require frequent maintenance and can cause burn injuries and contribute to respiratory disease among women and children. Solar lanterns, along with larger household solar systems could offer a safe and energy-efficient interim alternative to meet the growing demand for household lighting in India.

A special thanks to D.light Design (www.dlightdesign.com) for their willingness to work with CDF. This study was conducted by Selvan Thandapani and Richard Woodbridge, researchers with CDF's Rural Market Insight team.

For more learnable action research by Rural Market Insight, check out more briefs in this design series:

- Can Urban User Testing Reveal Relevant Insights for Rural BoP Consumer Energy Products?
- Can Urban User Testing Inform Prototyping of Rural BoP Products?

ADDITIONAL RESOURCES

Centre for Development Finance-IFMR
www.ifmr-cdf.in

International Institute for Sustainable Development
www.iisd.org

Quality of Experience
http://www.albendesign.com

Jawaharlal Nehru National Solar Mission
mnre.gov.in/pdf/mission-document-JNNSM.pdf

World Resources Institute
http;//www.wri.org

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