



User Testing of Household Water Treatment and Storage Products

In Andhra Pradesh, India

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PATH's Safe Water Project



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Preface

Ethnographic research methods such as extended observation, unguided interviews, participatory research, and rich media documentation have become a mainstay of product design research. Often called “user-centered research” or “user-experience research,” these methods provide detailed understanding of explicit and latent user needs and preferences as expressed through users’ physical, behavioral, and emotional responses to products. Often users provide direct input into design decisions.

Consumer product manufacturers and distributors are beginning to aggressively pursue low-income, “base of pyramid” (BoP)¹ users as an emerging market. Products targeting BoP users have commonly emphasized the practical features of “appropriate technology” over attributes such as product aesthetics and user experience that significantly affect demand generation and sustained use. Consumer product design research grounded in user-centered ethnographic observation has recently emerged as an effective tool for understanding BoP consumer preferences, behaviors, and demand.

To the authors’ knowledge, there have been no comprehensive product design research studies of BoP consumer appliances (apart from cellular telephones) outside of possible proprietary manufacturer research. For designers and developers of household water treatment and storage products, such research may provide valuable insights into user product interactions among BoP consumers. These insights may help product developers mitigate the pervasive barriers to adaption of and sustained use of HWTS noted by numerous researchers.^{2,3,4,5}

The Extended User Testing Study described in this report took a deep, qualitative look at HWTS product design and BoP user behavior. By meeting user needs through product attributes, product designers and developers will be able to affect consumer demand, product purchase, and sustainability of use.

¹ For purposes of this study, “low income” and “BoP” refer to families earning between US\$1 and \$5 per day.

² Clasen, TF. *Scaling up household water treatment among low-income populations*. (WHO/HSE/WSH/09.02). Geneva: World Health Organization; 2009. Available at: http://www.who.int/household_water/research/household_water_treatment/en/index.html.

³ Figueroa ME, Kincaid DL. *Social, Cultural and Behavioral Correlates of Household Water Treatment and Storage*. Center Publication HCI 2010-1. Baltimore: Johns Hopkins Bloomberg School of Public Health, Center for Communication Programs; 2010. Available at: <http://www.jhuccp.org/sites/all/files/Household%20Water%20Treatment%20and%20Storage%202010.pdf>.

⁴ Heierli, U. *Marketing Safe Water Systems: Why is it so Hard to Get Safe Water to the Poor—and so Profitable to Sell it to the Rich?* Berne, Switzerland: Swiss Agency for Development and Cooperation; 2008. Available at: <http://www.poverty.ch/safe-water.html>.

⁵ Schmidt, WP, Cairncross, S. *Household Water Treatment in Poor Populations: Is There Enough Evidence for Scaling Up Now?* Environmental Science and Technology; 2009.



Study design

The Extended User Testing (EUT) Study, commissioned by PATH under its Safe Water Project, was conducted by the Indian research firm Quicksand Design from March to December 2009 in the state of Andhra Pradesh, India. The overarching goal was to ensure that the needs and perspectives of potential low-income consumers of household water treatment and safe storage (HWTS) products in India were integrated into the Safe Water Project's product development activities. Specific objectives included:

- **Understanding user experience and preferences** by observing long-term use of selected HWTS products in the home and identifying product attributes that support sustained correct use or act as triggers for discontinuation.
- **Leveraging information on user experience for design**, specifically to develop a comprehensive design strategy based on identification of product attributes and features that could catalyze widespread HWTS product uptake and consistent, correct, and sustained use among targeted users.

Methods

The EUT study was a qualitative study of long-term user perceptions of and behaviors toward HWTS durable products. The research methods were grounded in the tradition of ethnographic documentation using rich media and participatory research tools such as photography, video, user journals, and codesign workshops. The study produced a highly descriptive account of product use experiences within a purposive sample of urban, peri-urban, and rural low-income consumers in Andhra Pradesh, India.

Design research creates an understanding of what product qualities will meet the perceptive, physical, emotional, and behavioral needs of a target market. It informs design in ways that enhance user satisfaction and product success. Design research normally precedes the design process and is important from the point of view of inspiring and informing the design and brand teams on new opportunities and brand innovation. Design research regularly participates in the redefinition of the design process away from the stand-alone object and into the integrated system. By moving away from the mere “styling” of the product and into the interlocking systems that manifest, support, constrain, and envelop

products and services, this form of user research ensures that the design interventions are holistic and deliver at several use levels. It is also often the more superior tool than market research in situations where innovation is the key objective rather than concept testing.

Laurel B. Design Research: Methods and Perspectives. Massachusetts Institute of Technology; 2003.

The EUT study design drew extensively from tools and methodologies of design research. It was developed and implemented by a multidisciplinary team of product designers, film makers, communication designers, social researchers, and business strategists. Each team member leveraged relevant skills from their professional area of expertise to ensure a well-rounded study design that considered not only engineering and physical design but social and economic factors influencing the use of HWTS products.



Qualitative research methods employed in the study included:

- Video ethnography and shadowing.
- Cultural guiding (by community members).
- Structured, in-depth interviews and unstructured contextual discussions.
- Role-playing with community members.
- Participatory workshops (focus groups and user codesign workshop, described later).

- Card-sort prioritization exercises (described later).
- Cultural probes (disposable cameras provided to participants for self-documentation).

Project Timeline

The EUT study began in late March 2009 and continued through the end of the year. During the first two months, participants were selected and interviewed about their water beliefs and practices. Next, they were each given a HWTS device to use in their homes for approximately six months. After product placement, team members made four additional visits to each household between May and December 2009 to document and discuss use and perceptions.

Table 1. Project timeline

Activity Milestone	Research Methods Employed	Date
Context Reconnaissance	Community Interviews	March 23–28, 2009
Participant Selection	Screeners Participant Interviews	April 6–15, 2009
Baseline Study	Video Ethnography Shadowing Sessions (A Day in the Life of...) In-depth Interviews Magic Box Water Eco-system Mapping Scenario Testing	April 23–May 7, 2009
Product Placement Product Revisit 1 Codesign Workshop	Expert Evaluation Role-Play Shadowing Time-lapse Photography In-depth Interviews Future Casting Participative Model Making	May 24–June 6, 2009
Mid-Course Review		July 15, 2009
Product Revisit 2	In-depth Interviews Role-Play Photo Probes Diary Probes Mapping Mental Models	July 27–August 4, 2009
Product Revisit 03	In-depth Interviews	September 5–10, 2009
Product Concept Development		September 10–30, 2009
EUT Final Presentation		November 3–5, 2009
Product Revisit 04	Focus Group Discussion Concept Evaluation	December 3–9, 2009
Final Report Hand Over		February 20, 2010

Site Selection and Recruitment of Participants

PATH's original study design specified a sample size of 20 households, divided among rural, peri-urban, and urban communities. Candidate study locations were selected in consultation with PATH representatives in Hyderabad who had extensive experience in the region. Site selection criteria included locations where:

- Poor water quality was a problem noted by residents.
- Water access or availability was a noted problem.
- Fluoride contamination was not a recognized concern.
- The target economic segments were well-represented.
- There was the greatest possible diversity of potential users within the sample segment.
- The logistics of travel and lodging for the research teams were manageable.

Research team members explored four neighboring districts near Hyderabad that provided sufficient diversity of household demographics, attitudes, and contexts. The goal of participant selection was to include families representing four variables: Urban/rural and upper/lower ends of the targeted income spectrum (US \$1 to \$5 a day).

Participant recruitment involved visiting villages, making introductions, setting up visits to potential participants' homes, and meeting members of candidate households. The team also met with the village Panchayat head (local village council head), the local medical clinic, school leaders, or local nongovernmental organizations to identify candidate households. The team shared a one-page description of the study with potential candidates (see Annex 1) as well as provided verbal explanations of the study objectives and criteria for participation. The fact sheet gave the team credibility because it clarified that the study was not related to political activities.⁶

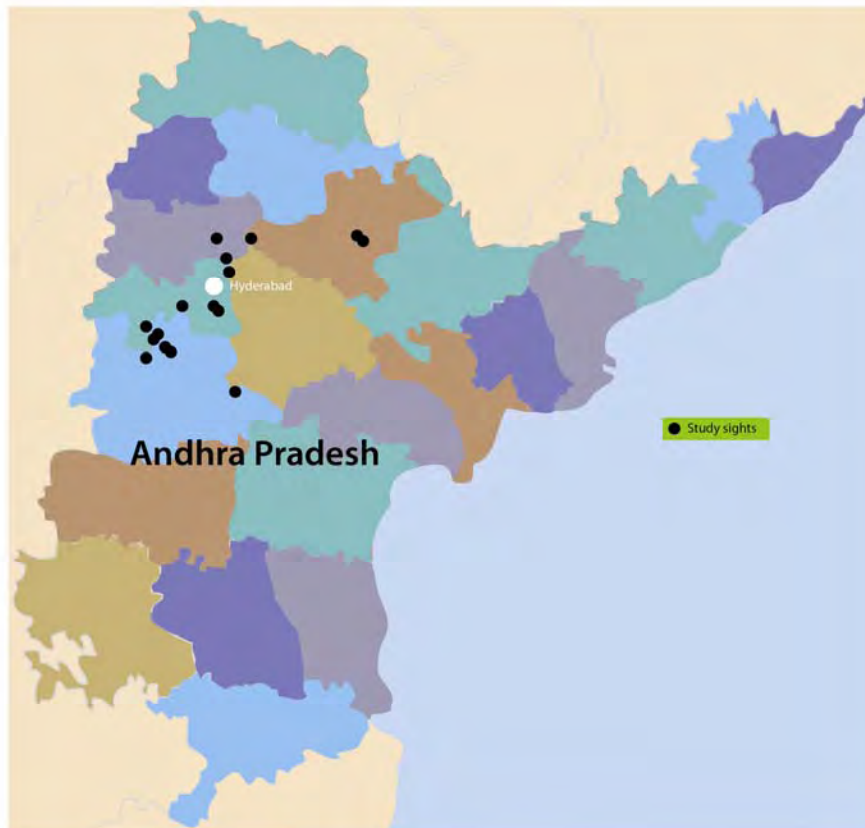
For the final participant selection, the team compiled a comparison sheet of basic demographic data, locations, and household profiles. The researchers then selected a purposive sample that reflected the desired number and distribution of households.

⁶ State elections were under way during our initial field visit.

Table 2. Site Selection: Districts and Community Locations

District	Location	Semi Urban/Rural
Mahbubnagar	Kakarlapadu	Rural
	Maderam	Rural
	Medwadkatanda	Rural
	Noornagar	Peri-urban
	Selmijalatanda	Rural
	Venkatpur Tanda	Rural
	Devarkadra	Peri-urban
	New Ganj	Peri-urban
Rangareddy	Medchal (2)	Peri-urban
	Boyaguda (2)	Urban
	Attapur	Urban
	Annanagar	Urban
	Jeedimetla	Peri-urban
Warangal	Padpendiyal	Rural
	Dharamsagar	Rural
	Hanumkonda	Peri-urban
Medak	Kondapakka	Rural

Figure 1. Map of study sites



Reconnaissance and Context Immersion

Two research teams of three to four people (two or three interviewers/designers and a translator/driver) visited candidate districts and locations. During these initial visits, the research teams documented the environment and home context with video, still pictures, and informal interviews with potential study participants in order to get a better understanding of first-time HWTS users.

Cultural Guides and External Support

The Quicksand research team was from Delhi and unfamiliar with Telugu society, language, and culture in Andhra Pradesh; therefore, they needed to engage local intermediaries for cultural guidance, logistics support, and language translation in the field. The research team chose cultural guides from the local community, which was invaluable for all stages of the project. The presence of familiar faces on the team created goodwill and trust among participants, and the cultural guides made it possible to access participants even when the research team was back in New Delhi.

Participant Screening

During the reconnaissance visit, the team used a screening questionnaire (Annex 2) to identify the final 20 participating households. This tool provided a demographic profile of the household, identified basic water-related practices and access to markets, estimated economic status, and confirmed the participating households had not participated in prior research and were interested and available to enroll in our study. The research team became acutely aware that self-estimates of income and observed lifestyle and tangible assets could be misleading and did not always provide accurate economic status estimates. In the end, economic status estimates were based on a combination of context, asset observation, and participant interviews.

Informed Consent

To finalize recruitment, the final 20 study families were read a description of the project, asked if they would like to participate, and requested to sign a consent form confirming their permission for the team to photograph, record, and videotape the research sessions. The form was as short and simple as possible, and verbal informed consent was accepted when participants had low-literacy competencies.

Baseline Context Activities

Researcher teams performed initial data collection visits to establish a contextual reference for each of the participating households. Baseline data described the state of the household and its members prior to introduction of the filter units in terms of their context; demographics; and perceptions and attitudes toward water, HWTS, and health in general. Future visits would refer to this baseline to assess changes in variables over time.

Typically, household baseline visits lasted four to six hours and included observations, interviews, and activities with one or more members of the household. Because most water-related activities happen in the morning, research teams arrived at each home at dawn or earlier and stayed until early afternoon.

Activity Guide

An activity guide integrated all the research activities to ensure consistency across the two teams and several researchers. The guide had three sections accompanied by a conversation guide. The sections were (a) Context Description, (b) Behaviors, Attitudes, and Perceptions, and (c) Goals and Motivations. The activities described in the guide ranged from purely observational to interactive and participatory research techniques. Such techniques included “A day in the life of...,” asset inventory, self-photo probes, and mapping exercises. These data collection techniques are further described in the report section on “Product Placement Activities.”

The team collected baseline data in a knowledge base that includes detailed transcripts, activity outcomes, rich media documents (such as picture sets and filmed scenarios), and actionable insights. The baseline synthesis also established tracking variables for the team to reference during future visits (variables included water sources, usage and practices, consumption, perceptions about water, and water treatment and health). Baseline findings are further described under “Observations and Findings on the Context of Use.”



Selection and Evaluation of HWTS Products

Five HWTS products were originally selected for the study. A sixth product was chosen to replace one that failed during the study. The products were chosen if they were:

- In commercial production in India or elsewhere.
- Designed specifically for base of pyramid (BoP) consumers or with features appropriate for BoP consumers.
- Compliant with conditions of the design brief chosen by PATH (volume, gravity-fed, mechanical filtration, non-electric, etc.)
- Proven efficient at removing microbiological contaminants from water.
- Representative of diversity in product form factors, aesthetics, usability, complexity/simplicity, and filtration methods.

Only consumer-durable devices—rather than consumable water treatments such as disinfectant liquids, powders, or tablets—were used for the study to enable comparability of user experience, behaviors, and interactions with the products and their physical attributes.

Once the study products had been selected and procured,⁷ the research team built heuristics, or rules, to evaluate product usability and functionality. The products selected were:

⁷ Neither the Ceramic Water Pot (CWP) nor the Lifestraw Family (LSF) is commercially available in India. Five CWPs were procured in Cambodia. Although the LSF may soon be available through nongovernment organizational

Table 3. Products tested in the study

Product	Technology	Manufacture	Capacity (in liters)	Cost in rupees (and approximate US dollars)
Ceramic water pot	Mechanical filtration: earthenware filter treated with colloidal silver	International Development Enterprises (IDE), Cambodia	10	519 (\$11)
LifeStraw Family	Mechanical filtration: hollow fiber ultrafiltration	Vestergaard Frandsen, Switzerland	2	950 (\$20)
Stainless steel gravity filter	Mechanical filtration: ceramic candle filters	Rama, India	34	1,500 (\$32)
AquaSure	Multi-stage mechanical filtration and chemical disinfection	Eureka Forbes, India	18	1,800 (\$39)
PureIt	Multi-stage mechanical filtration and chemical disinfection	Hindustan Lever, India	18	2,000 (\$43)
Kent Gold	Multi-stage mechanical filtration, absorption, and hollow fiber membrane filtration	Kent R.O. Systems	20	2,498 (\$50)

All four LifeStraw Family devices failed, and they were replaced by Kent Gold devices during the third revisit.

channels in India, the study samples were sourced directly from the manufacturer. The remaining products were procured through retail channels in India.

Product Placement Activities

The team introduced the HWTS devices to households during the second visit to study sites. This provided an opportunity to observe initial user experiences with the products, emphasizing orientation, assembly, and first use. Researchers first visited the households to introduce the products and conduct in-depth interviews. They returned a few days later to observe initial product experiences.

Researchers also simulated different purchase scenarios when the products were introduced, as outlined in Table 3.

Table 4. Purchase scenarios

Scenario	Description
Stork Delivery	An unopened filter package was delivered to the home, and participants were asked to set it up without any instruction or demonstration from the research team.
Simulated Shopkeeper	A research team member posed as a shopkeeper at the home and gave cursory instructions on how to set up and use the product; the users were then asked to set up and use the product themselves.
Traveling Salesman	A research team member played the role of a traveling salesman who set up the product in the household and demonstrated cleaning and maintenance procedures.
Actual Retail	Users were accompanied by the research team to an actual retail store and given money to purchase the product.

When introducing the products, the team employed observation, activity, and conversation guides in the field. Some of the data collection instruments used are listed in Table 5.

Table 5. Sample data collection techniques

Sample Data Collection Technique	Description
Product prioritization flashcards	Participants ranked a series of illustrations of products most commonly found in low-income households (fan, mobile phone, radio, etc.) as well as some aspirational products (refrigerator, water filter) based on what they considered most valuable. Afterwards, they rated the illustrations based on perceived costs of the devices.
In-depth interviews	These were discussion-based, semi-structured interviews with the head of household to gather insights about first experiences with the products.
Use probes: use calendar and fill diaries	In the first month, image-based diaries were left

Sample Data Collection Technique	Description
	with respondents to track product interactions by maintaining and recording basic activities (who dispenses water and at what times of day, for what purpose, etc.).
Telephone-a-friend role-play	Participants enacted a scenario wherein they had bought the product at a store and had to describe what they liked/disliked about the product to a friend on the phone.
Mapping: HWTS schematic map and water ecosystem	A kit of locally sourced images used to identify HWTS activities and artifacts in a household and create a water ecosystem map.
Participant self-photo probes	Each household study was given a film camera and instructed to document water sources, related activities, and experience using the treatment device. This technique engaged participants and facilitated storytelling.
Magic box	Participants were presented a box and were asked to imagine that the box represented their ideal/magical water filter. They were asked specific questions such as: <i>What does your ideal filter do? What features does it have? How much does it cost? Where will you place the filter? How long will it last?</i> This technique elicited device expectations and desires for various parameters. It worked particularly well in rural settings.

Codesign Workshop

A codesign workshop (see Annex 3) was organized during the product placement in May 2009. Nine participants were recruited from households in Hyderabad that had been previously screened for participation in the study.⁸ The workshop objectives were:

- Evaluate the capacity of typical end-users to conceptualize HWTS product solutions using 2D and 3D design tools.
- Gain a more intimate understanding of user needs and expectations as expressed through creative narratives.
- Develop codesign facilitation tools and methods and assess their effectiveness.
- Identify novel HWTS product features or attributes for incorporation into design prototypes.
- Consider the value and viability of establishing an “expert user group” of experienced end-user/reviewers to evaluate future design prototypes and iterations.

The workshop was split across four activities:

⁸ The codesign participants reflected the better-educated upper end of the BoP market and the study sample at large.

Future casting: Introduction to the workshop used printed and projected images to familiarize participants with the idea of thinking about the future with respect to their lives, dreams, and hopes. After viewing images of various “futuristic” scenarios, participants did a “warm-up” to brainstorm creative solutions to challenges identified by each.

Imagineering: Building on the unconstrained brainstorming, participants were encouraged to think about more concrete individual dreams and aspirations. These were first discussed in the context of everyday activities (such as education, entertainment, transportation, communication) and then specifically with regard to water-related tasks and activities. This exercise was done with two smaller groups of participants. Each group had a facilitator and a translator. Designers/visualizers helped each group communicate its solutions through graphic schematics and sketches.

Make it real: Using an assortment of found objects and components purchased prior to the workshop, participants were asked to build physical prototypes of idealized HWTS products that would fulfill each user’s needs.

Show and tell: Each participant was asked to present his or her prototype to the rest of the group for critique.

Workshop Outcomes

The quality of the workshop output was surprisingly high given participants’ lack of experience with HWTS products. The unconstrained format allowed users to demonstrate their ability to come up with innovative, credible, and well-thought-out product concepts. Interesting insights generated during the workshop included:

- Users were interested in portable water treatment devices and in devices designed expressly for use by children.
- Users placed a high value on chilled water and on water treated and stored in traditional materials such as copper, brass, and earthenware.
- Users had an accurate mental model of filter components and of water treatment processes.
- Users demonstrated a strong aesthetic sense and preferences for materials, forms, and colors.

Household Revisits

Following the baseline and product placement visits, the team made four more household visits to observe product use and track changes in behaviors and attitudes toward water treatment. The table below summarizes the schedule. The longitudinal nature of this research allowed observation of seasonal water quality variations and their impact on treatment behaviors.

Table 6. Revisit schedule by season

Visit	Week	Month	Season
Product Placement	00	May-June	Summer
Revisit 01	01	May-June	Summer
Revisit 02	05	July-Aug	Summer
Revisit 03	11	September	Monsoon
Revisit 04	19	December	Winter

Focus Group Discussions

Toward the end of the research schedule, the team organized two focus groups of users. These discussions allowed feedback from now-experienced users on other filter devices that were part of the study. This shift of the participant from a novice to an experienced user was considered important in gathering deeper insights about the products. The focus groups were also used to get reactions on visual product concept forms that were prepared in conjunction with a parallel design effort.



Observation and findings on the context of use

The study findings are contextual; therefore, this section offers a description of the baseline household context for the people involved in the study, their habits and practices around water, and the belief systems that support these practices.

People

Recognizing the small sample size of the population included in the study, we have described a picture of the context in which they live. We highlighted commonalities and convergent viewpoints that may be extrapolated to other parts of India or beyond.

User Profiles

The study team analyzed observational data to identify five distinct user profiles among the 20 study families. These profiles reflect populations existing within the BoP market that any design or marketing intervention could target. The user profiles were developed in light of key variables such as location, water sources, social awareness, family size, and income. The user profiles differ from one another in terms of their awareness of and attitudes toward HWTS practices and products.

Differences among families in urban, peri-urban, and rural locations are notable when observing degrees of interdependence and sharing among community members, awareness of modern consumer products, and integration with the mainstream economy. Social awareness differs depending on whether there are educated, younger household members capable of influencing behavior among elders. Family size determines the degree of responsibility sharing among family members and hence the social support system available to the chief wage earner. Finally, income—the most obvious differentiator—determines whether the family is favorably predisposed to HWTS products as a means of bettering their lifestyle.

Each user profile is briefly described below:

Young adults: three study households, mostly from peri-urban locations. These families are characterized by the presence of a young male (18 to 25 years of age) who is the most educated and informed decision-maker in the household. They are eager to adopt new products and are favorably predisposed to water treatment products and practices because of their education.

New responsibilities: six households. The chief wage earner in these households is between 25 and 35 years of age and has dependent parents to look after besides his wife and usually two or

three children under the age of 12. These families are well-placed economically with the promise of a better future and have migrated to urban centers for better career opportunities. These families aspire to obtain products that can provide a better lifestyle and health for their family.

Mid-life strugglers: six households. With larger families to support and poorer economic status, these families are characterized by daily wage earners with insecure incomes. Financial limitations put education largely out of reach. Durable products are seen as a luxury and are therefore a low priority.

New earners: three households. These are small, nuclear families (two or three members) located in urban centers. Both the husband and wife may be working; therefore, these households have a larger disposable income and are more liberal with their expenses. HWTS products are valued for their health benefits, especially for newborns.

Extended support systems: two households. These households have several related families staying together (up to 15 to 20 family members), mostly in rural locations, and have a predominantly agricultural background. Resources are shared among families, and ownership boundaries are vague. These families are largely insulated from mainstream influences and have strong internal support systems. Aspiration for durable products or safe water products in particular is quite low unless triggered by a family member who has gone to live in the city and come back.

Household Dynamics

Responsibility for household chores is usually split between men and women. Labor-intensive activities, such as fetching water from distant water sources, are done by the men, whereas women procure water from nearby sources and take care of household chores such as cooking, cleaning, and washing. In agricultural households, women often support their husbands in the fields while also taking care of the house. Children are often change agents responsible for making sense of new products and technology for elders. If there is an eldest son, he is the heir apparent, and family members look up to him for guidance and decision-making.

Families in rural locations collectively share resources and responsibilities—more often than urban families. Consequently, people in rural locations spent more time together with their friends, neighbors, and relatives and were more willing to “lend a helping hand” to each other. In urban locations, families were more nuclear, with clearer demarcation of roles and responsibilities. Rural locations also tend to be sensitive to caste distinctions, with members of the same religious community staying together. These differences get diffused in urban centers where most inhabitants are migrants.

“Since we are Baniyas (a trader community), we do not like people touching our household objects. I have placed the filter in this room so that people coming home can see it but not touch it.”

Study participant, Medchal

Practices

Daily Routines and Rituals

Both rural and urban homes almost always have a fixed routine for the first few hours of the day. Days start between 5:00 and 6:00 a.m. Mornings are very active, with the first couple of hours spent in fetching water, sweeping the house, preparing tea, cooking food, washing utensils, cleaning, and bathing. Because morning hours are times of peak use at the water source, household members try to go earlier or later to beat the rush. It can take between 20 and 30 minutes to fetch water.



Context often shapes the daily habits and practices of individual households, particularly around water use. Most practices depend on water sources, access to water, income to purchase storage vessels, and location. Described here are typical practices and habits related to water use, treatment, and storage.

Table 7. Daily routines of household members

	5:00–10:00 am	10:00 am–3:00 pm	3:00–7:00 pm	7:00–10:00 pm
Men	Fetch water,* tend to fields, eat breakfast, bathe.	Work in the fields, may or may not return home for lunch.	Return from work, fetch water,* rest and socialize.	Eat dinner and go to sleep.
Women	Clean, cook, wash utensils and clothes.	Prepare lunch, leave for work, eat lunch.	Return from work, prepare dinner, rest and socialize.	Eat dinner and go to sleep.
Children	Help with fetching water, cleaning, and cooking.	Leave for school, return and eat lunch.	Rest and play, help with fetching water and cooking.	Eat dinner and sleep.
Young children & elderly	The elderly stay at home, help the head of the household and their spouse with household activities, and take care of the young children at home.			

** In many areas of India, it is more common for women to fetch water. In this particular sample more of the men and children were responsible for fetching water.*

Between 10:00 am and 3:00 pm there is a lull period for water-related activities when household members are either at work or resting. Working members in peri-urban locations do not return home until evening, but in rural locations they may come home for lunch because of the proximity of the fields to their houses. By 6:00 pm, the woman in charge begins preparation for dinner while in most homes the men or children fetch water. The whole family generally eats dinner together between 8:00 and 9:00 pm, after which they retire to bed.

In summer, rising temperatures make it difficult for people to work in the fields in the afternoon. People consequently start work an hour earlier. Harvest season is the busiest time of year in villages, and working household members leave very early for work and return later in the evening. During these months, the children and the elders also help with fieldwork and other household chores.

Daily wage earners and self-employed people work through the week. Those who are employed do not work on Sundays or official holidays. This is most common for families in urban locations.

Water Sources

On average, households in the study had access to two or three water sources in their community. Only two households had direct access to water (through a piped connection inside their homes); the others had to collect water from the community sources.

Among houses using water from two sources, users assign different uses—such as drinking or washing—to each source. Most users stated that a government water tank is their preferred source of water. They noted that the government treats the water to a certain degree before supplying it, and because a large population is accessing the water, they believe it to be reliable.

Respondents access tank water through taps located on the boundary of the government water tank. Since tank water is supplied infrequently during limited hours, its use is limited to drinking and then cooking.

In most of the houses, the second source of water is bore water, which is more available and accessible. This water is supplied through motor or hand-operated pumps. Each settlement may have several pumps convenient to clusters of houses that users can access throughout the day. Bore water is used for cleaning, washing clothes and utensils, and bathing.

“For maintaining good health, clean and safe water is very important. We can use other water for washing and other purposes, but for cooking and drinking we need clean and safe water. So for that, a filter is very essential... So if we have water filters, then all the harmful bacteria or micro-organisms and dirt particles are removed and water is made clean and safe for consumption.”

Study participant, Kondapaka

In rural locations, a few households have access to a third source of water, which is an agricultural bore or *Bowri*. This water is used to water the fields and is used as a fallback for household purposes when water is in short supply or when water quality from other sources changes dramatically.

Other available sources of water include locally treated mineral water, water pouches, and mineral water bottles and cans. These are available in quantities ranging from 500 mL to 20 L and can cost anywhere from Rs. 1 to Rs. 25. None of the households visited during the study consume this water daily, but family members purchase packaged water on occasion. Mineral water is purchased when someone is traveling, away from home/work, or when someone in the family falls ill.

Most of the respondents who work away from home do not carry drinking water with them. In rural locations, respondents use water available in the fields through the bore for drinking. In urban locations, users drink water available at their work place, which is usually filtered water. Some children carry a bottle of water to school, but most drink water that is available at school (the quality of which has not been documented).

The most common reason for selecting a water source is the perceived quality. Users evaluate water quality largely on the basis of taste and color. Good-quality water is described as being “*safed*” (clear) and “*meetha*” (sweet). The next factor for selecting a source is its reliability, usually described in terms of availability and consistency of taste and color. In our study sample, users travel from 0.5 km to 2 km to access drinking water. Most respondents said they are willing to spend more time and effort to access good-quality water. In most families, both urban and rural, users tend to stock up on water in case of shortage or unreliability of the source.

Most users could think of at least one instance of changing their source of water for a small duration. This was often triggered either by illness in the family or by community-wide illness due to contaminated water. This finding suggests that some users understand the link between dirty water and poor health.

“Change in usage of water can be influenced by someone new in the family. Ever since Shekhar’s sister started using drinking water for cooking rice, they have gotten used to it now and continue to do so, even after she has left.”

Study participant, Boyagudda

Water Containers and Their Use

All households own an array of containers, which are used to fill, transport, store, and consume water. The material properties and capacities of these containers define their usage.

Steel: Steel is viewed as an easy-to-clean and durable material that fits in well with the rest of the kitchen. Most households own two or three steel bindals, with a capacity of 15 to 20 L each. These bindals are used to store drinking and cooking water. Steel glasses and lota⁹ are used for drinking and dispensing water from the bindals. Users stated that they found it easy to gauge the price of steel and aluminum utensils as they are priced by weight (steel bindal 15 L, Rs. 200–250; sarva 4 L, Rs. 140; lota 1–1.5 L, Rs. 100; glass 500 mL, Rs. 40).

Clay: Most households own one clay ghara,¹⁰ which is used to store water for drinking during summers. Clay gharas may be found in smaller capacities of 10 to 12 L and are only used in summers to keep drinking water cool. They are heavy to carry and easily breakable. They are seen as an expensive purchase (Rs. 60–100) because they have a short life span and usually only last for one season. In some cases, a small clay pot with a capacity of 5 to 6 L is used to store and transport water. This is usually wrapped with a wet cloth to keep the water cool through evaporation.

Plastic: Plastic bindals are ubiquitous among the households in our study population. They are most commonly used to transport water because they are lightweight, convenient to carry, and relatively inexpensive to replace if damaged. Most users noted that plastic bindals are difficult to clean because they have a small mouth and that water stored in them smells of plastic. For these reasons, plastic bindals are used only to store water for washing and cleaning. Plastic bindals come in different grades and have a scrap value. A used plastic bindal, when returned, gets Rs. 5 off the purchase of a new bindal, which costs approximately Rs. 25–30.

Plastic jerry cans and bubble tops¹¹ are sometimes used as substitutes for bindals to transport water because they are very easy to carry on cycles. Used plastic beverage bottles are also commonly found in most households. Working members and children use these bottles to carry water to work or to school.

Copper or Bronze: Copper or bronze vessels are rare and usually inherited. Water stored in these vessels is considered to be good for health.

⁹ Lota is a steel vessel of 2- to 4-L capacity usually used for dispensing water from a bindal for drinking and cooking.

¹⁰ Ghara is a earthenware pot of 10- to 20-L capacity used to keep water cool during summers .

¹¹ Bubble tops are blow-molded plastic jars of 15-L capacity. They are commonly used to package treated water (mineral water).

Table 8. Evaluations of water by storage container

Most users ascribed qualities to water based on the material of the storage container	
Steel	Water in steel is clean, remains at moderate temperature, and does not smell.
Plastic	Water in plastic smells of plastic, becomes “sticky,” and remains warm.
Clay	Water in clay is cool and sometimes (in new pots) smells of mud.

Social and Cultural Traditions

In both rural and urban locations, we found that people and communities are very closely intertwined. Families form their opinions about services and products based on what their relatives, neighbors, and friends have to say. This is more prevalent in rural locations, however, because people in villages spend more time with the community. In urban locations, household decisions are more influenced by members of the immediate family.

Many households make big purchases during festive seasons and occasions such as weddings and Grah-Pravesh (house-warming). Festivals are also the time most products are on discount or come with good deals. For women, festivals are the time to purchase new steel utensils for the kitchen or as part of their daughter’s wedding trousseau. Plates, glasses, lotas, bindals, chairs, almirahs, and sometimes even steel candle filters are commonly part of the trousseau.

“I buy a new item every January on Sakranti (harvest festival). This year, I bought a bike.”

Study participant, Medchal

“I have never seen a filter till now. But if my daughter wants it, I will buy it for her wedding. And we will buy it for ourselves, if my son wants it.”

Female neighbor of study participant, Kondapaka

Perceptions and Beliefs

Often, practices around water are driven by perceptions and belief systems that are less about location and incomes than about culture, religion, and history. These beliefs are deeply held and difficult to change. As such, they are extremely illustrative and important for product designer and marketers to consider when developing and selling products to cultural groups outside of one’s own norms.

Beliefs and Practices About Water

Among the families visited, common water perceptions and practices included:

Water gets old: Participants stated that water that has been stored for more than 24 hours becomes old and smells stale. In all households, fresh water is collected every morning for drinking and cooking, even though there might be water remaining from the previous day (which gets used for cleaning and washing).

Boiled water is curative: Boiling water for consumption is a curative practice and is adopted either during an illness in the family, when preparing milk for newborns, or when the source of water has been changed temporarily. Users noted that although boiling kills germs and removes the saltiness from water, it also removes the taste. The cost of boiling is perceived in terms of time rather than fuel and is considered a time-consuming process (15 to 20 minutes). In a rare case, it was practiced as an everyday ritual in the rainy season.

”Boiled water does not have any taste. The doctor tells us to give the children boiled water, but the children do not like that water.”

Study participant, Boyagudda

“When the water is boiled, all the germs get killed. Before boiling, the water tastes somewhat sweet. After boiling it is a bit tasteless. Filtered water tastes different. It should be tasty. Boiling cleans the water even better than a filter will. In a filter, the water remains cold, so the germs might not die. But boiling the water will remove 100% of the germs.”

Study participant, Boyagudda

Straining water removes dirt: Most users stated that straining removes visible dirt while boiling removes invisible dirt. During rainy seasons, water is filtered at the source with a cloth. Some stated that water was filtered after it was brought home, while it was being transferred from plastic bindals to steel bindals. A plastic net may also be used for straining if there are larger dirt particles in the water. Allowing dirt particles to settle is another way of removing them before “clean” water is then transferred to another vessel.

Different water has different uses: In all the households, infrequent water supply led respondents to store water in vessels and tanks of various sizes. Water is segregated on the basis of its usage and stored accordingly. Drinking water is stored in steel bindals (and kept at an accessible place in the house), while plastic pots are mostly used for transportation. Clay is used to store water in the summer, primarily to keep it cool. The steel bindals are covered with a lid with a glass placed on top which is used for dipping and drinking. Water for cleaning and bathing is stored outside the house in the courtyard in plastic bindals. Aluminum vessels are used for cooking and boiling. All vessels are washed using soap, ash, or dry earth once a week and rinsed every time before filling.

The water is generally clean: Most respondents recognized the relationship between unclean or “bad” water and poor health, though they also reported that their water is clean most times of the year. Most users stated that their need for a filter or filtered water is temporary and transient (mostly during rainy seasons or while traveling) and that their natural body immunity could ward off most water borne diseases. One user stated that when he purchases a bottle of mineral water at the railway station, he refills it with regular water for the rest of the journey. Buying chilled, packaged water in summers, however, is a common phenomenon with most study participants. A small set of respondents said that they did not trust locally filtered water as they were unsure of the water source.

Perceptions About Water Quality

Most users' perception of water quality was based on source, taste, and color. Most respondents referred to their water by the name of the source from which it comes, which is usually a reservoir (for example, *Manjeera* water or *Burmajiguda* water). Good-quality water is described as having a sweet taste, no odor, and being clear in color. The majority of users perceived bore water to be salty with visible suspended particles and dramatic quality variations from season to season.

Users ascribed other qualities to water as well. Some of these are:

- Water that is whitish is believed to contain chlorine or fluoride.
- Salty water makes cows give good milk.
- Mineral water causes joint pains.
- Mixing bleaching powder in the water changes the odor of water, which is undesirable.

Participants largely attributed illnesses to changes in weather or seasons rather than to water quality. Most respondents stated that they could easily perceive inferior quality in food but have difficulty judging the quality of water.

Market Participation

Influencers: For respondents and families in both urban and rural locations, social networks, extended families, and immediate community are the most important channels for learning about products and forming positive opinions that lead to a purchase. When it comes to buying products, different members of the family have a say in different products. Although the head of the household is the key decision-maker for most purchases, young adults are consulted for technology purchases, and women make purchase decisions for low-risk, essential consumables. The presence of newborns and young children in the household can create a new set of needs with regard to products and practices.

“I learn about new products from the TV or from friends and relatives. If there is an item I would like to buy, I speak to friends and relatives. I then visit a shop if I want to know more about the item.”

Study participant, Kondapaka

“Now that I have a baby, I need to buy a fan for him.”

Study participant, Boyagudda

Awareness: Most respondents in rural locations have one or more members of the family living and working in a big city. They stated that they feel products purchased from the city are of good quality, are durable, and perform well. Demand for durable products is also built through what respondents and their families see in urban or more affluent homes and aspire to own themselves.

Most households in the study owned televisions, DVD players, and mobile phones. Participants noted that TV advertisements are an important means to building product awareness and create a desire to own the product, but they do not drive the actual purchase. Triggers for purchasing a product are different, especially for products that are novel. The efficacy of advertising depends

on how it feeds into social conversations, which are a more prominent influence on buying decisions.

“I saw a filter in Reddy’s (land owner) house, when I went there for a function.”

Study participant, Paadependiyal

Product life: Many participants wanted to see a correlation between the care they give a product and its useful life. There was an expectation that “quality” products that are well maintained will continue to function well beyond their advertised life.

Retail channels: In peri-urban locations, most respondents said they purchased most of their household goods from a neighborhood store (usually a one-stop shop) or a Bundi Wallah (cart salesman). These channels are preferred for low-risk, low-value essentials. To purchase more expensive and aspirational products, such as televisions, respondents preferred a showroom in a more formal marketplace.

Value for money: Most respondents stated that they could judge the proper price of utensils and vessels since they were sold by weight. They said they would always bargain for a better price when purchasing durables such as a radio or wall clock because they are unable to estimate its actual cost.

For some respondents, warranties are a must-have for durable products even though they may never use warranty services. Servicing and ease of repair are critical factors for some people when deciding between brands. Respondents also stated that they expected the cost of doorstep services and support to be high and hence would not prefer to have them. The discard or resale value of a product is another critical attribute for decision-making.

“We bought an Onida TV, and not a Sony or LG because spare parts are easily available.”

Study participant, Selmijalatanda

“A mechanic or salesperson will charge more if they come to the home.”

Study participant, Devarkadra

“I gave away old vessels and in return got a discount of Rs. 100 on the purchase of two new steel *bindals*.”

Study participant, Noornagar

Perceptions of HWTS Products

Although some participants were aware of HWTS products, very few had ever seen a water filter before the study. The research team repeated questions about perceptions of water treatment products at the end of the study when respondents had more experience with devices. Steel candle filters were the most commonly known form and brand of HWTS product among the sample households. A few respondents, however, were also aware of electrically operated ultraviolet and reverse osmosis filters.

“Electrically operated filters are not safe, especially when there are children in the home. The water in the electrically operated filter looks like it is boiling.”

Study participant, Annanagar

At baseline, most study participants said that the ideal cost of a filter should be between Rs. 500 and Rs. 1,000, contingent upon specifications such as the capacity of the filter, quality of the material used, the brand, and the warranty that came with the device. Large volumes of approximately one bindal capacity (15 to 20 L) were favored.

Users were asked about the features of their “ideal” filter. Most stated that the filter should clean and purify the water by removing all the dust and dirt particles. The ideal filter should also soften the water and convert salty water to sweet water.

Most users perceived the filter as a durable product and were curious why the components needed frequent replacement. To seek help on using a filter, most users said that they would first approach the shopkeeper or the person demonstrating the product. Next, they would ask their friends for help, and as a last resort they would refer to the user manual of the product.

Participants became aware of HWTS products primarily from seeing a filter in the house of a friend/relative or in the market. Water filters were seen as “novel” products and, like other durable products, need to be endorsed by the community before purchase.

“I do not want to purchase a filter because I do not know anybody who owns one.”

Study participant, Medchal

Summary of key baseline findings:

- Home water treatment is an episodic activity to meet special needs.
- Treatment of water is valued less than other attributes such as availability, access, and storage.
- While both men and women collect water, women tend to be the custodians of water use in the home.
- Water is transferred from one container to another at multiple points before consumption, increasing risk and opportunities for contamination.
- Adoption of an HWTS product depends as much on the device as it does on product awareness, service delivery, and ease of repair and maintenance.



User experience of products

Household visits allowed researchers to observe user behaviors and experiences over several seasons and through multiple phases of the product life cycle (discovery and enquiry, setup and installation, use, and cleaning and maintenance). The research team gathered information through interviews with key respondents from all of the households as well as through observations and conversations with other household members. Key findings are outlined below.

Discovery and Enquiry

Product discovery and enquiry was often a collaborative effort between household members and a close set of community members (neighbors and relatives). In rural households, large audiences of community members would usually participate in the setup and first use of the devices.

First Impressions

Initial user reactions to products usually related to the form, materials, aesthetics, and mechanism of the filter. Most respondents quickly categorized their products as aspirational, novel, or ordinary, through wording such as “the filter is ordinary looking” or “the filter is too classy to own.”

Initial product perceptions changed during extended use. The ceramic water pot filter that was initially perceived as “not novel” was later described as “simple and easy to use,” and the Aquasure filter that was called “too technical” was later “easily understood

Form perceptions: When asked to describe impressions of product form, respondents primarily referenced size/height, volume, and shape. Filters in the form of two stacked containers fit well with users’ existing mental model of a filter.

In the case of cylindrical forms such as the Rama Candle Filter and the CWP, respondents felt they would fit in well visually with the other products in their homes but were ordinary looking. Respondents reacted positively to products with asymmetrical forms (such as AquaSure and Pureit) and felt that the filters appeared novel and would improve the “show” of their house.

For the most part respondents and their families were most positive about medium and large filters (8 to 9 L upper container capacity for medium filters and greater than 9 L capacity for large). Respondents associate size with capacity and prefer a filter that holds more water for daily consumption.

Material perceptions: Users had clear preferences for certain product materials, as described earlier. Not surprisingly, respondents were most positive about filters made of steel. Despite concerns over plastic's fragility, respondents differentiated between soft and hard plastic and appreciated the colors and the combinations of clear and opaque plastic available.

The type of material influenced responsibility for filter care. Steel filters were maintained like other common steel utensils. Filters made of fragile materials such as plastic and clay were maintained by the heads of households or their spouses.

In the context study, respondents associated water quality with the type of material the water was stored in. Although respondents ascribed similar properties to water stored in steel, plastic, or clay filters, they felt that water stored in plastic filters had a "plastic smell" and stayed warm, while water in earthenware remained cool.

Water quality perceptions: Respondents expected their filter to remove dirt and dust particles, kill bacteria, remove the taste of bleaching powder, and make hard water soft. A common perception of multistage filters was that water treated in the filter was as clean as boiled water. This may or may not be linked to participants' familiarity with the "safe as boiled water" slogan used by Hindustan Lever in advertising the Pureit product.

Most respondents with access to government-supplied water did not note a drastic change in water quality after filtering it, though some felt that the smell of bleaching powder in the water lessened after filtering. Respondents with access to bore water noted significant differences in their filtered water. They felt that the water from the filter was clear and tasty and was softer than untreated bore water. Respondents who used filtered water for cooking felt that food cooked in this water tasted better.

Respondents' perceptions about treated water attributes were also influenced by perceptions of others in the immediate community. When neighbors noted a difference in the water, respondents felt positive about their filter.

Perceptions about how filters work: Filter elements included single-stage and multistage configurations. The researchers hypothesized that users would engage more with devices when they understand how they worked, leading to more consistent and correct use. Users understood the function of familiar components such as prefilters and ceramic candles but were baffled by components such as polishers and ultra filtration (UF) membranes.

Respondents described ceramic candles and the clay pot as "simple" filters that were easy to use and understand but did not understand how multistage filters work. However, multistage filters were perceived as more advanced products that treat water better than single-stage filters.

Instructions and Manual



During product setup and use, we noted that printed product information and instructions were rarely interpreted directly by the user. They may first be understood by an intermediary who then interprets them for the actual user. Because children are often the only educated household members, they frequently help adults make sense of the products and instructions, becoming de-facto “experts” who adults turn to repeatedly for assistance.

Packaging

Most respondents and their families referred to the product illustration on the packaging while assembling the filter. Once the filter was set up, most respondents would reference the packaging for further instructions about how to use the device. However, the packaging did not provide cues for further use, maintenance, or assembly for most products.

In most houses, packaging was not discarded but was used to store manuals, warranty cards, cleaning tools, and spare parts that came with the filter.

Illustrations versus instructions: During product placement, respondents and their families first tried to assemble the devices without reference to instruction manuals or other sources of information. They turned to the manual or package information only when initial assembly attempts failed.

During the initial setup, graphical user assistance was far more communicative than textual information for the low-literacy consumer segment. Respondents and their families easily understood graphical illustrations in product manuals and instructions. For example, users clearly

understood the instructions included with the Rabbit Ceramic Water Pot filter (imported from Cambodia), despite the Khmer text. For setting up complex multistage filters, respondents found the manual of little help. Even in households where children could read the manual, the children were unable to understand words like “carbon trap” and “polisher.”

Setup and Installation



During selected product placement scenarios where researchers used a show-and-tell setup to demonstrate product setup and installation, involving a group ensured that a close set of stakeholders (and not just users) were trained on the product and could help in subsequent troubleshooting. Even when participants were asked to assemble products with no instruction (the “stork scenario”), other family and community members commonly observed and helped to set up the product.

Assembly

Products that came in a preassembled package made it easier for study families to set them up successfully for use. While preassembly may reduce setup errors, it is important to make sure that the preassembly does not dumb down the installation process completely. Products requiring more assembly encouraged user discovery. Respondents who felt capable/confident of their ability to set up the product were observed to be more engaged and motivated to discover and familiarize themselves with the devices.

Products such as the ceramic candle filter, which required a screwdriver to fit the knob to the lid, left users who did not have tools hard-pressed for workarounds in the absence of assistance or guidance.

Most respondents could correctly configure major components such as storage containers but were often unable to configure filter components easily. Elderly respondents did not easily understand snap-fit assemblies. Intuitive assemblies made respondents confident they had fitted the parts correctly, but with larger numbers of components and complex assemblies, respondents stated they did not know whether the assembly was correct.

Location

Tabletop filters must be placed on a raised surface. Because kitchen counters or shelves were rare among study households, most participants placed their filters on a low wooden stool. The filters were raised from the ground so the tap was high enough to allow filling a glass or a *lota*.

Tabletop filters were preferred to wall-hung filters. Respondents had difficulty finding an ideal location or height for wall-hung filters, and the filter was placed where the existing nails were.

In most homes, tabletop filters were placed near the water storage containers to have easy access to water for the filter. None of the families placed filters outdoors because they felt that dirt and dust would dirty the filter. Filter locations rarely changed during the study, except when the filter was taken outside for cleaning.

Soaking the Filter Element

The initial process of soaking the filter element did not fit the existing practices of filter use among the study households. Most respondents did not understand the purpose of the process and required coaching to do it correctly. Although they understood that the procedure had to be followed, they were unable to say why, making it less likely that it will become habitual. Respondents would like their filter to start working instantly but were willing to wait for up to 30 minutes while the filter element was soaked.

Presoaking filter elements required a certain quantity of clean water, which is frequently unavailable. Most families had difficulty finding sufficient quantities of clean water to presoak the clay pot or a container large enough to accommodate the pot itself.

First Fill for Discarding

Most users had to be told to discard the first water treated by the filter. That the first batch of treated water might be unpalatable contradicted user expectations for the devices.

Use



Product use experiences varied according to the type of user (young, old, male, female, etc.), the design and materials for each device, product aesthetics and configuration, and the task being performed (filling, cleaning, processing water, dispensing, etc.).

Water Ecosystem

Water used to fill the HWTS devices came only from “clean” water sources (i.e., highest available quality). No households filled their filter with water from secondary sources (i.e., water used for cleaning/washing). Respondents said they would continue to drink water from their “clean” water source even if they were filtering it.

Morning water-collection routines remained exactly as they had been before filter placement. Water was collected by the same family members as before and at the same time. The artifacts used to collect water remained the same as well. In most cases, these were steel or plastic bindals, jerrycans, or bubble tops.

Filling

Most respondents reported the amount of water consumed for all drinking and cooking activities in a day in terms of the number of pots used. For example, for a family of five or six, the amount of water consumed during summer was equivalent to two or three bindals (30 to 45 L). For HWTS products, respondents kept track of the number of pots of water poured into the upper container as a measure of the amount of water consumed. Over extended use, scheduling activities became much easier because there was an easy way to remember the amount of water filled, and people did not have to worry about water running out in the interim.

Responsibility for filling the device usually rests with the older adults in the house. This responsibility may still rotate among the young adult in the house, the housewife, the husband, or the dependent parents who may also live in the house.

The routine for putting water in the device follows a morning-evening cycle. Water remaining from the previous day is emptied out and used for other nondrinking purposes. A fresh batch of water is poured in the morning, and this can last through the day, depending on the season. The first filling is poured directly from the collection vessel, but subsequent fillings are done with water stored in designated containers, usually steel or plastic bindals. The preferred height for filling is below shoulder level. Depending on the height of the filter, this required placing the filter on the floor, on a short stool/chair, or on the counter top.

The level of water remaining in the bottom container is the trigger for replenishing water in the top container. Users preferred not to let the filter go dry, so users may refill the upper container before the bottom container is entirely empty. Users had to guesstimate how much water the bottom container can accommodate before overflowing. In the event of an overflow, users said they would dispense the excess immediately through the tap.

Working Indicators

Active engagement with the devices was thought to inspire greater care and sense of ownership. Engagement was promoted through product status indicators. Indicators may confirm that the device is working (water is falling from one chamber to the next) or that the filtration process is working (water is getting treated between the upper container and the lower one).

Indicators include:

- Status indicators designed into devices (water-level indicators, transparent containers or lids, battery-life indicators).
- Cues discovered by respondents (sound of water droplets falling, wet clay pot indicating water level).
- Cues indicating that the more complex, hidden parts of a product are effectively filtering water (dirt settled on the ceramic candles, discoloration of the prefilter).

Prefilters provided the best evidence that the filter is working. Visible stains and dirt on the prefilter indicated to users that the water was being cleaned. A clogged prefilter was the clearest cue that the device was removing contaminants from the water.

Processing Time

The average time taken to filter a batch of water (6 to 9 L) was two to three hours. With most devices, it took 15 to 20 minutes for the water to start flowing and 30 minutes to filter a lota (2-4 liters) of water. In case of the CWP, respondents noted that the processing rate was very slow, and they had to wait for up to 60 minutes for a small batch of filtered water. Respondents felt that waiting for 30 minutes was acceptable when they did not need “instant” water. Families required filtered water mostly in the mornings. In the majority of households the two or three lotas of water remaining in the filter from the previous day were used for drinking and preparing tea while users waited for the fresh batch of water. If water was filtered too fast, users felt that the water was not being cleaned properly or that the filter was malfunctioning.

Dispensing

How successfully an HWTS product is adopted by a household is due in part to the extent that it is usable by all members of the family. One factor affecting usability is the height at which water is filled and dispensed.

Elders usually filled the device with water, but all household members dispensed water from the filter. When devices were placed on a low stool or kitchen counter, children could access the tap, and the top of the device remained inaccessible (thereby preventing them from dipping their hands in the upper container). Because a fair bit of activity happens on the floor (such as cutting vegetables or having meals), this is also the most appropriate height for dispensing water while squatting on the floor. This height does not require users to bend a great deal from a standing position.

There are typically two scenarios for dispensing: 1) holding the vessel under the tap for smaller quantities of water dispensed in glasses or lotas and 2) placing the vessel on the floor under the filter for larger quantities of water dispensed into small pots called sarva (3 to 5 L) or polyethylene terephthalate (PET) bottles

Most households routinely had a small steel glass (approximately 350 mL) placed on top of or beside the filter. Household members share this glass to consume water spontaneously during the day. Planned consumption happens when water is taken out for a larger group. Water is collected in a sarva or in PET bottles for family members to carry potable water with them. Water for cooking is dispensed into the cooking utensil itself—usually a lota or sarva (1.5 to 3 L). Water for washing vegetables and rice is dispensed into the same vessels.

Over time, treated water may be used for purposes other than drinking, such as preparing tea and cooking rice. In smaller households filtered water was used to wash vegetables and rice.

Self-reported consumption ranged from 5 or 6 L per person per day in summer to around 3 L in the rainy season. Periods of greatest drinking water consumption are in the mornings (before children and elders leave for school and work respectively) and later in the evenings (when the family comes together for the last meal in the day).

Users stated that the device should treat water quickly so that enough is available for consumption during peak periods.

Tap

HWTS products were among the few devices in study households with taps. Most users were satisfied with the flow rate and the function of the tap but worried that they were fragile and could be easily damaged. Respondents used two-state taps (that dispense only when actively held down, or flip up for a continuous flow) in both states to dispense water in small and large quantities. Respondents appreciated taps with adjustable flow rates because they could control the flow rate depending on the volume of the container being filled.

Cleaning

Cleaning kitchen utensils is part of the daily ritual of any household. Like any vessel or water storage container in the house, HWTS products underwent a daily cleaning cycle. For the respondents and their families, cleaning the filter regularly is a small intervention that—in their perception—helps enhance the life of the filter.

The cleaning protocol of these families varied from a mild wash (daily) to a thorough scrub (biweekly or weekly). Although the HWTS devices were handled with more care than usual for other kitchen utensils, daily cleaning subjects them to more abrasive wear and tear than they may be designed for. Most of the tested HWTS products came with instructions that specified cleaning (involving thorough disassembly) only every one or two weeks. During the study, almost all households casually cleaned both the upper and lower container every day. A casual cleaning would involve mild scrubbing with hands and plain water or wiping it with a cloth. The treated water in the lower container if left from the previous day would be taken out in a vessel and used for nondrinking purposes. A fresh batch of water would be poured into the upper container once this daily cleaning was over.

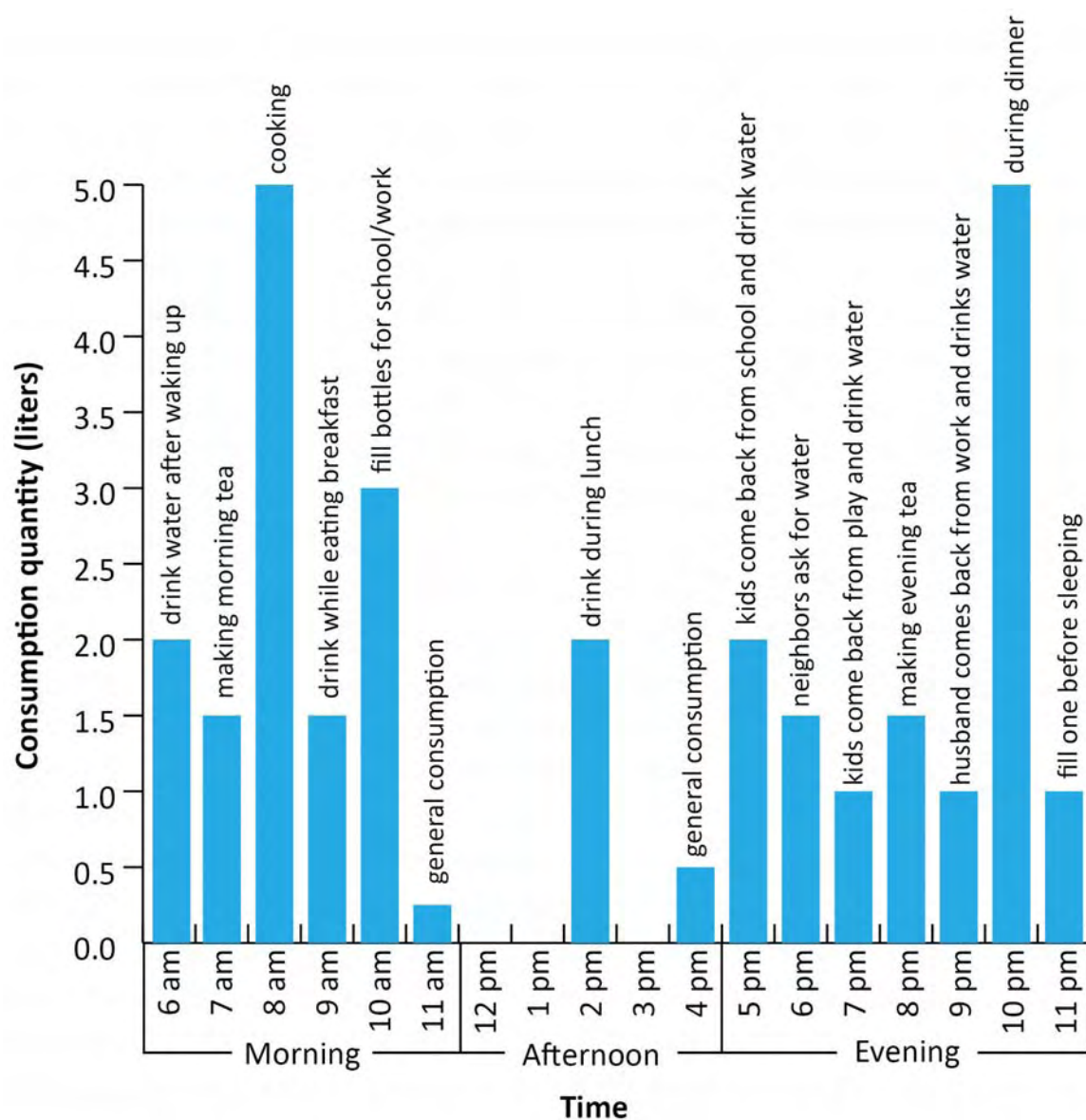
More thorough cleaning occurred every five to seven days. Most families would use soap or detergent to clean the upper container. When instructed, most families avoided using soap or detergent in the lower container. In some instances, however, such as when the prefilter or the candle was visibly very dirty, respondents used soap or detergent to clean the components. Typical cleaning rituals would involve rubbing with a plastic scrub or with hands, soaking candles in warm water, and using soap or detergent (despite instructions to the contrary).

The cleaning procedures mentioned above could occur either inside or outside of the home. In rural or peri-urban locations, where houses have more space and typically have cleaning areas outside, the filter would be moved every day between its installed location and the cleaning area.

Most HWTS products came with accessories for special cleaning procedures, such as back-flushing filter cartridges. Accessories played an important role in helping users remember the need to periodically perform the cleaning procedure. They also drove engagement with device components (such as the filter cartridge) that otherwise did not merit any interaction.

Filter elements themselves typically do not exhibit visible signs of wear and tear in the way that a component such as the prefilter does (by clogging or becoming visibly dirty). Cleaning procedures such as back-flushing appeared to give users a sense of control and that they were able to clean and enhance the life of the filter engine. Back-flushing also provides physical evidence that the filter is working by discharging dirt that may be clogging up the treatment element.

Figure 2. Consumption quantities



Service, Support, and Maintenance

While some tested products came with clear instructions to replace the filter elements every six months, the idea seemed to challenge households' assumptions about durable products. In addition, criteria for replacing filter elements were unclear for most of the products tested, which lacked end-of-life indicators like a flowstop device. Study participants did not understand why they were supposed to replace the filter elements when the product still appeared to be functioning—although at a slower rate—in some cases without actually treating the water. Most participants said they would prefer to pay to replace individual components rather than complete subassemblies.

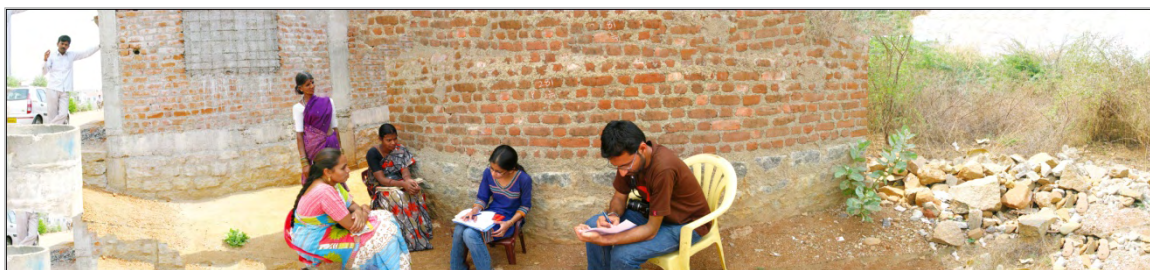
Users had certain expectations for durable products and consumable products. Durable products can be characterized by the following attributes:

- They come with a prescribed life (usually indicated by warranty).
- The expected product life for our target segment is usually a multiple of the warranted life (for example, a television with a two-year warranty is expected to last anywhere between five and ten years).
- They do not have a prescribed replacement schedule for their parts.
- The user has a mental model for maintenance requirements that is constructed according to what they feel is needed to keep the product functional and effective (for example, a mobile phone would be serviced only when it stops functioning).
- Breakdowns are usually repaired using locally available components.

Consumables, by contrast, are characterized as:

- Products that are meant for immediate consumption and that are linked to utility (detergent sachets, small-volume oil bottles) or instant gratification (mineral water, chilled water package).
- Easily accessed and available.
- Having a low purchase price and needing to be purchased repeatedly.
- Not requiring maintenance or care.

Combining attributes of both durable and consumable products, HWTS products are positioned in users' minds on a spectrum between consumables and durables.



Design interventions and recommendations

Findings from the study can directly inform the design and development of durable products targeted to BoP consumers. Similarly, user experience testing can also help companies plan the commercialization of products marketed to BoP consumer segments.

Product Design and Development

Product design and development efforts need to focus on product features and attributes that drive a favorable user experience throughout a product's life cycle. Some of the attributes pertinent to specific stages of product use and that were important for most study families are highlighted below.

Desirable Aesthetics

The initial purchase and adoption of an HWTS product can be influenced greatly by leveraging the aesthetic perceptions associated with materials and forms in BoP markets. It is important to recognize and design around well-entrenched perceptions surrounding commonly used materials such as steel, plastic, and ceramics. Similarly, the importance of novelty can be seen in the tastes and preferences of BoP consumers. Designers may want to keep the following in mind when addressing aesthetic attributes of an HWTS product:

Steel is seen as a traditional, highly durable material. Plastic, by contrast, has a more modern appeal and is available in a variety of colors, transparencies, and shapes. Users are extremely sensitive to the grade and quality of plastic.

Round and cylindrical shapes resemble most vessels and containers already found in BoP homes and may be considered traditional and old-fashioned when compared to more asymmetrical or angular shapes.

Features That Facilitate Product Discovery

Creating shared knowledge within a close set of community members during the initial product discovery and sense-making stage (mostly at the time of unpacking and assembly) can create a sustainable support system for the product over its lifetime. This can be achieved by:

- Encouraging users to collaborate with a larger group (their neighbors and relatives) during product sense-making.
- Involving children in the initial setup since they tend to remember instructions and are usually looked upon as “sense-makers” of new technologies.

- Using visual media and anecdotal instructions while demonstrating products because they are far more communicative to a low-literacy audience that is generally dismissive of text-based instructions.

Children usually assisted elders with cleaning and tended to remember cleaning protocols and assembly. Most respondents stated that if they needed help in understanding and using a new product, they would ask a neighbor or friend.

Intuitive Assembly

Assembly is the first interaction that a user has with a product and is therefore critical in driving first impressions. Incorrect assembly or comprehension of the product during initial use can become habitual and lead to suboptimal performance or even hazardous consequences for users. The absence of clear indications that a product is being assembled or used incorrectly may prevent consumers from taking remedial action and result in early abandonment of the product. Methods to facilitate more intuitive assembly include:

- Making users feel intelligent about the product by providing positive feedback during assembly. Devices that come out of the packaging semi-assembled can help drive user discovery while still being fairly easy to set up.
- Developing an assembly process that is self-sufficient and requires no additional accessories or tools.
- Ensuring that there is only one correct way of assembling a product.
- Providing indicators or shut-off mechanisms that signal improper functioning and communicate clearly to users about the fault.
- Offering sales and service support that respects consumers and speaks to them in appropriate language.
- Providing exhaustive and illustrative instructions of the correct process.

The locking mechanism of the carbon trap in the Pureit was easy to understand because it provides a motion feedback when locked properly. Although most elderly users stated that they were confident of this assembly, they were unable to snap-lock the prefilter in place because they did not have any previous experience with similar mechanisms.

Consideration of All Household Users

Product use can be increased by designing the HWTS device so that end-users can easily fill the device and dispense water from it. Adults, both men and women, are primarily responsible for filling the device. For dispensing water, the device needs to be used by all members of the household, including children. Designers must thus ensure that:

- The filling height is ergonomically appropriate for users of most ages and height (specifically, for lifting a water-filled vessel [typically 15 L] to fill the top container).
- Users can place a vessel under the tap and dispense water into it.
- Children can reach the tap without having access to the upper container (thereby preventing them from dipping their hands into it).
- The tap height is accessible from a standing or squatting height.

- The device is stable even when completely filled with water.

Although it may be difficult to accommodate all requirements in a single device, it may be possible to design accessories such as stands or provide variants that are more suited to specific needs.

In houses with the Rama Candle filter, most respondents tended to keep the filter at table- top height. Although it was difficult to pour water into the filter, adults were willing to make the extra effort to allow a height at which their children could easily access the tap.

Products That Align With Users' Mental Models

In order to facilitate desired use behaviors and build confidence about the product, it is important to keep users' mental models¹² in mind throughout the product design process.

One of the most prevalent mental models among BoP users is cleaning and how it helps to improve filter performance. Providing visible cues of the dirt getting removed when the user cleans the device and its components is one way to accommodate this mental model. Conversely, designing the product to communicate to users when additional cleaning is unlikely to improve filter performance, especially toward the end of filter element life, can prevent filter misuse or overuse.

The other prevalent mental model is users' understanding of the filtration process. A device that clearly shows either the extraction of dirt or removal of germs while it happens (in much the same way a prefilter does) can address this expectation.

Respondents using filters with prefilters stated that they knew the filter was working because they could see the collected dirt and dust particles in the prefilter. Most respondents were also cleaning the prefilter more often than the other filter components because it looked dirty.

Adequate Filtration Rate

The device should provide adequate quantities of treated water for multiple uses in the household and at a rate that meets needs during intense periods of use in mornings and evenings. The device must also accommodate higher rates of consumption during periods of high demand, such as summers. An HWTS product that adequately addresses users' consumption needs should fulfill the following requirements:

- Provide for per capita consumption of 5 to 6 L in summer and 2 to 3 L in rainy seasons or winter.
- Have a filtration rate that provides at least 3 to 5 L of water in the first 30 minutes of filling, which usually happens in the morning.

¹² A mental model is an explanation of someone's thought process about how something works in the real world.

- Should have enough buffer capacity for guests, neighbors, and children who are frequent visitors in almost any BoP home.

“Good” Water

Outside of microbiological efficacy of filtration, the HWTS product must address users’ expectations for what they perceive as “good water.”

Reassurance about treated water quality comes from visual and other sensory cues such as clarity, odor, and taste. Water clarity becomes a particularly important attribute during the rainy season when source water turns muddy and users are sensitive to the need for clear drinking water. Similarly, odors due to chemical treatment or storage in low-grade plastic pots are easily discernible by users and are a disincentive to consumption.

It is important for the filter element to set targets for water aesthetics as well as for microbiological performance.

Unambiguous Indicators

For users to consistently and sustainably engage with the HWTS device and correctly perform all tasks needed to ensure the device functions properly, the product must provide users with unambiguous indicators of its operational status and prompts for maintenance or repair. Active engagement of the users with the product can ensure better care and a greater sense of ownership. Clear status indicators can also reduce the frustration a user is likely to face due to assembly or maintenance errors.

User experiences that can be enhanced with well-designed indicators or cues include:

- Knowing the level of water in the upper or lower container (for example, through transparent containers or level indicators).
- Ensuring that the clarity of treated water is visible to the user.
- Knowing how much water can be added to the upper container while avoiding overflow in the lower container.
- Knowing how long the water in the upper container will last (by accommodating one complete pot of water in the upper container, users can better estimate how long the water will last).
- Knowing how long the filter will continue to operate effectively (through end-of-life indicators).
- Knowing when the filter components need to be cleaned.
- Differentiating a malfunction such as a leakage from normal functioning.
- Indicating that the device is functioning properly (by seeing the water flow from the top container to the lower container or hearing the sound of falling water).
- Indicating that the filtration mechanism is working effectively (through visible signs of dirt extraction or symbolic representations of germ removal for the device components responsible for treatment).

Durability

The HWTS device should withstand deterioration and clogging due to high levels of salts and dissolved solids commonly found in water collected by low-income households. It also needs to

withstand not only the wear and tear of scheduled cleaning and maintenance but also the daily cleaning rituals of most low-income households. The cleaning protocols of these families vary from a mild wash to a thorough scrub. Although the HWTS devices are handled with more care than usual, a daily cleaning cycle subjects them to abrasive wear that they may not be designed for. The frequency of these cleaning practices and constant handling (for example, in moving the device from inside the home to outside for cleaning) requires use of more robust materials and construction than plastic multistage devices currently exhibit.

Highly turbid water in these regions, especially in rainy seasons, also requires high-performance mechanical filtration components such as prefilters. These components tend to clog faster in rural areas than in urban markets. Therefore, replacement costs for these components must be lower and decoupled from the purchase of the main filter cartridge to make frequent replacements more affordable.

Cleaning is part of the daily ritual of any household. To minimize the behavior change demanded of users to adopt a new technology, such as household water treatment, the product's use should integrate into existing behaviors as seamlessly as possible. This includes ingrained habits such as daily cleaning of water containers and cooking utensils. The ability to withstand frequent (daily) cleaning without degrading filter performance will minimize behavior change required for adoption and sustained use.

Long Shelf Life

An HWTS device must have the life of a durable product but have recurring costs comparable to those of a consumable product. It is important to understand the expectations of BoP users for durable and consumable products and to use that as a basis to correctly position an HWTS product. Durable products are expected to have a long service life (usually much beyond the warranted life of the product), should require little or no replacement and repair, and should be serviceable locally or by the consumers themselves. Consumables, by contrast, are products meant for immediate consumption, are usually linked to utility, are readily available, and have a low per-unit cost.

An HWTS product appropriately positioned somewhere along this spectrum should therefore have the following characteristics:

- The replaceable components should be low cost if they require frequent replacement.
- The storage device should have a long service life, with local serviceability.

Commercializing HWTS Products

The success of an HWTS product, especially for our target segment, depends heavily on the ecosystem that supports initial uptake and sustained use. Awareness and availability of these products has to be increased in order to increase market penetration of water treatment products. Ways to nurture the larger product ecosystem are outlined below.

Leverage Community Influence

Given the strong influence of communities on choices made by individual BoP consumers, community opinions need to be mobilized to drive awareness and adoption of any new product. Seeding a new product by demonstrating it to a community and initiating trials with selected

opinion leaders can trigger word-of-mouth endorsement that spreads rapidly and effectively. Product demonstrations or a show-and-tell selling model are often employed by salesmen to generate interest and trials among users in these markets.

Especially in rural areas, communities exhibit a great deal of interdependence, which can be evidenced in:

- Sharing of public resources, which are often the anchor around which lives within a community revolve. Responsible use of these resources requires interdependence of community members.
- Sharing of experiences through word-of-mouth influence, particularly in oral cultures and shared living spaces such as multifamily compounds.

Such a tightly knit social system can be highly effective in driving initial uptake of novel technologies such as HWTS products. This social system may also increase the risk of unanimous, rapid rejection if the product fails to live up to expectations.

Target Decision-Makers

Communication targeted to specific user groups can be more effective than generic, value-based communication strategies for facilitating product adoption. Each of the five user profiles discussed earlier in the report represent a decision-maker who is differently predisposed to health and hygiene issues. For “new earners,” the presence of a newborn in the house is an automatic trigger to adopt safe water practices, whereas for “mid-life strugglers,” an extreme case of illness that can take away valuable working days might be a stronger motivation.

An effective way to target these decision-makers is through direct communication that speaks to the needs and aspirations of a specific user group. A case in point is the widely used communication strategy by one such commercially available product where the key benefit being communicated is that water treated by the device is “as safe as boiled water.” While the benefits of boiled water are widely understood, it is not an effective call to action for the larger BoP audience, for whom boiling water is not perceived as necessary. Instead, the same proposition holds a lot more value for a “new earner” who has a newborn in the family.

Given the extremely low penetration of water treatment products in BoP markets, it is essential for a successful product strategy to generate initial trials among users; this may be possible only through a user-centered value proposition customized for different user groups.

Devise an Effective Retail Strategy

Given the importance of both formal and informal retail channels in the BoP economy, it is important to leverage them for their strengths while creating a retail strategy for HWTS products.

While formal retail channels are aspirational and high on credibility—and are thus trusted for most durable purchases—they are also unfamiliar and slightly intimidating environments for BoP consumers. Informal retail markets, by contrast, are trustworthy, familiar, and accessible for everyday, low-risk, low-value purchases where consumers can make an acceptable trade-off between price and quality. These markets can therefore be used very effectively for relatively low-cost HWTS consumables. Their easy accessibility can also bring down some of the barriers consumers have towards continued use of an HWTS product.

Price the Product Appropriately

The expectations of the BoP consumer, based on the price of a product, can be gauged by determining where the product lies on a spectrum with utilitarian products on one end and aspirational products on the other. Segmentation of assets owned by study households demonstrates that the products can broadly be classified into two categories:

- Lifestyle durables consisting of relatively high-value products such as mobile phones, bicycles, televisions, entertainment devices (such as CD players), refrigerators, and watches. These products are calculated indulgences hoped to provide a better lifestyle along with a dual role of being utilitarian and being aspirational.
- Kitchen durables consisting of low-value products such as kitchen utensils along with higher-value products such as pressure cookers, gas stoves, wet-grinders (in few houses), and storage tanks. These are necessities and have a primarily utilitarian purpose.

Water-treatment products are clearly seen as aspirational products but also fall in the realm of kitchen durables. An ideal price point for an HWTS product, when interpolated between these two extremes, falls between Rs. 500 and Rs. 1,000. It is equally important, as part of the pricing strategy, to offer product warranties as part of the product deal.

A warranty represents what the user desires of a product—trouble-free operation that requires no recurring investment on the owner's part. The expected life of the product may in fact be several multiples of the warranty period. But warranties reaffirm a user's expectation that a product will last without any trouble.

Facilitate a Service and Repair Ecology

It is important that the HWTS products fit within the service and repair ecology that exists within BoP markets, especially keeping in mind the repair and reuse paradigm. This becomes particularly important for a product category (such as HWTS products) that has little or no precedence in BoP markets. Typically, household products (refrigerators, televisions, etc.) have a well-developed repair ecosystem with local fixes, work-arounds, and replacement parts that are readily available or scavenged off more expensive variants.

An important pillar for any product strategy would be how the local repair economy is trained and equipped to handle repair and unscheduled maintenance of an HWTS product. The product should be designed in a way that can be integrated into an existing repair market for HWTS products, albeit for more affluent users.



Conclusions

Study Design

While the EUT study provides findings and recommendations that can facilitate an effective HWTs product strategy for BoP markets, it also provides a framework for research and design pertinent to product development for low-income populations.

Key take-aways from the study methodology include:

- A multidisciplinary team of business, design, technology, and research experts provide invaluable insights for navigating the complex eco-system of consumer products for BoP markets.
- A favorable product-use experience in these markets consists of several levels of social and cultural interactions that have to be included within the design and development process and that can be effectively addressed by a multidisciplinary research framework.

Research methodologies: While several methodologies used in the EUT study are widely used social research practices, their application to design research for BoP is novel. Rich media (video, photography, and visual design) are extremely valuable for documenting use contexts and building understanding among stakeholders who may be removed from the context. This visual approach was highly successful in overcoming barriers related to low-literacy levels among the study population.

Limitations: While offering tremendous strengths in terms of user insights and opportunities for deep interaction with participants, the study's research methods also faced some limitations, as outlined below.

Rich media can provide a uniquely detailed picture of the product use context and are extremely effective for generating empathic understanding among audiences. Translating the data into an equally accessible text-based document proved a major challenge. The study's use of three different languages (English, Hindi, and Telugu) was a challenge for translation and interpretation.

Extended family networks and dynamic employment status, especially in rural communities, made it difficult to collect accurate economic and demographic data. Some research tools used in the study (such as photo-probes, diaries, and scenario testing) were unfamiliar to the study participants and had varying degrees of success.

HWTS Product Strategy

The product ecosystem for HWTS products for BoP markets consists of an extremely nascent context, low awareness levels, and a use environment that is incredibly rigorous and demanding of consumer products. This has several implications for both product design and commercialization. HWTS products for BoP markets need to:

- Withstand above-average wear and tear.
- Minimize risk of incorrect use.
- Have minimal redundancy by way of components and parts.
- Be designed for an extended group of users besides the primary users.
- Be affordable while keeping in mind users' extreme sensitivity to quality.

The flip side to a well-designed product is a well-equipped product ecosystem. Key goals to consider while designing the ecosystem are:

- Leveraging the community to drive influence.
- Effectively using both formal and informal markets that exist in these contexts.
- Equipping and facilitating a repair ecology.
- A balanced approach between product and system design can increase the likelihood of widespread adoption of HWTS products among low-income populations.

Overall

The data collected served two important study objectives:

- They allow us to compare and articulate changes in user behavior over time, with a focus on triggers for HWTS product adoption, correct use, or abandonment.
- They build a more comprehensive picture of user habits, attitudes, and perceptions toward household water treatment activities seen from a longitudinal perspective.

Appendix – Summary of Study Products

Ceramic Water Pot



Technical Specs: Capacity: 10 L total (5+5); cost: Rs. 250 (at point of sale in Cambodia); filtration technology: earthenware filter treated with antimicrobial colloidal silver (mechanical filtration).

During the study, the Rabbit Ceramic Water Pot was placed in four households.

Table 9. Placement of ceramic water pot

Location name	Noornagar	Dharamsagar	Medchal	Boyagudda
Family (income)	Syed Ali (Rs. 2,500 p/m)	Cornell (Rs. 6,000-7,000 p/m)	Subramaniam (Rs. 6,000-7,000 p/m)	Suresh (Rs. 5,000 p/m)
Type of location	peri-urban	rural	peri-urban	urban
Water source	hand-operated bore	agricultural bore	government water tank	government water tank
Number of family members	5	5	5	3
Family members under 6 years old	none	none	son & daughter	son
Family members 7-14 years old	daughter	none	none	none
Family members 15-59 years old	father, son & daughters	father, mother, 2 sons & daughter	grandmother, father & mother	father & mother
Family members 60 years old and above	none	none	none	none

We conducted five visits to each household between May and December 2009 and gathered information based on in-depth interviews with key respondents as well as extended observation of all household members using the filter.

The CWP was perceived as a simple, easy-to-understand, unobtrusive product. Respondents noted they appreciated that it was simple to operate and that its use was self-explanatory. They were satisfied with the product's performance and stated that none of their earthenware filters broke in the past eight months (though the taps of two devices did). They also felt that the product fit in well with the rest of the objects in their household environments.

Product Perceptions: A common initial reaction among respondents when the CWP was placed in their houses was that it was an ordinary looking product and lacked novelty. Most respondents stated that the parts of the CWP resembled common household objects such as plastic buckets and planting pots. For this reason, the CWP was not perceived as a consumer durable but as a basic household object. Although the novelty factor for the CWP was low, respondents did appreciate the material used, the functionality, and colors. They stated that the colors were nonintrusive. Household members valued the transparent plastic for the clean water receptacle because it made it easy to check the water level and determine if the filter was properly functioning. While respondents felt that the clay pot was fragile and would have a short life, they appreciated the functionality of the material and believed that it would keep the water cool while it was being filtered.

We asked our respondents to talk about the filtration process and their understanding of it. Although most of the respondents were unable to understand how the clay pot works to treat water, they could describe the process as “simple technology.” Respondents used the analogy of familiar ceramic candle filters to describe how the clay pot functioned, by blocking dirt and letting the clean water through. Most of the respondents were aware of more complex HWTS technologies and products available in the market but said they were satisfied with the CWP’s functionality. They also felt that since the product and technology were simple, the filter would be cheaper than other filters available in the market.

Setup and Assembly: During placement, the respondents could easily assemble the filter without any assistance or without referring to the visual instructions on the poster (textual instructions were written in Khmer and unintelligible to users). Some of the respondents went through the instructions on the poster after assembling the product to look for cues on use, cleaning, and maintenance. During the initial setup, respondents and their families had difficulty procuring a container or vessel large enough to fit the clay pot as well as a large quantity of clean water to soak the clay pot in. Most of the respondents soaked the clay pot in large water containers or tanks that stored untreated water for washing, cleaning, and bathing. Respondents also stated that the initial time taken to soak and set up the filter (recommended 12-hour soaking) was very long.

In all the houses, the CWP was placed inside the house, near the stored water and the cooking corner. The filter was raised and placed at a height, usually on a small stool or a shelf, that enabled a lota or a glass to be placed under it. One respondent moved his CWP from a tall table to a lower stool because he feared it might break if it fell off of the table.

Use: The research team observed that respondents continued to source the same quantity of water at the same time of day as before placement of the filter. Although different members of the household procured the water, only the head of the household or the spouse filled the device. Respondents stated that they feared the clay pot would break if someone accidentally dropped the bindal while filling the CWP.

All respondents stated that the capacity of the filter was enough for drinking consumption during rainy season and winters, but it was less satisfactory during summers because they had to fill the filter twice as often. No one noted concerns about overflows from the CWP due to overfilling. Respondents did state that the processing time could be faster because more water is required in the mornings. In one household, we noted that the respondent

had started filling the CWP at night to have enough filtered water for the morning, but this was not common practice among the other households.

The filtered water in all households was initially used for drinking. If there was any water left after that, it was used for preparing tea and cooking curries. While only the elders in the household filled the filter, all family members dispensed water from the filter.

Respondents stated that they liked being able to adjust the flow from the tap but had to be careful while using it because they felt it was fragile.

Cleaning and Maintenance: Initially, the CWP was cleaned once a week. With extended use, it was cleaned more often. In all households, the CWP was cleaned by the head of the household or the men. Respondents said they feared that the heavy clay pot might break during cleaning and noted that it had to be handled very carefully. Settling of dirt on the clay pot and the plastic bucket were noted as indications for cleaning. Two respondents noted that the filter's tap handle broke. They said that they would have to go to a bigger town to source a similar tap for the CWP.

LifeStraw Family



Technical Specs: Capacity: 2 L; cost: approx. \$20 (Rs. 950); filtration technology: Hollowfiber ultrafiltration (mechanical filtration).

The LifeStraw Family (LSF) was placed in three households for five months, from May to September 2009. (Note: Devices were initially placed in four households, but one device was immediately found to be inoperable, and no replacement was available.)

Table 10. Placement of LifeStraw Family

Location name	Boyagudda	Medwadkatanda	Jeedimetla
Family (income) person/month (p/m)	Shekhar (Rs. 4,000-6,000 p/m)	Balu Naik (Rs. 5,000 p/m)	Nagabhushan (Rs. 4,000 p/m)
Type of location	urban	rural	peri-urban
Water source	government water tank	bore tank	water tanker
Number of family members	3	6	5
Family members under 6 years old	daughter	none	daughter
Family members 7-14 years old	none	none	none
Family members 15-59 years old	father & mother	father & mother, son & daughter-in-law, 2 sons	grandfather & grandmother, son & daughter-in-law
Family members 60 years old and above	none	none	none

During the third visit to these households, in September 2009, the research team found that all three had discontinued using the filter. In two households, respondents stopped using the filter because the reduced flow rate made it very difficult to dispense water for consumption. In the third household, respondents stated that cracks had appeared on the body of the hollowfiber filter component, from which the water was leaking out, and this led them to abandon the filter. Since the LSF is not commercially available in India, we replaced the filters in these households with a Kent Gold filter (20 L, UF membrane). These filters were placed in households in September 2009, and their use was documented over the next two visits.

Among all the placed filters, the LSF was perceived as the most foreign to the respondents' environment. Most of them said they were not familiar with the physical

appearance and could not relate it to anything else in their environment. Although the choice of colors was seen as unique, one respondent felt that the LSF looked like a medical clinical filter that she felt would work well. Most respondents stated that unlike other plastic filters, the LSF was made of good-quality, durable plastic that would withstand the daily wear and tear in these households (though this was contradicted by experience).

Product Perceptions: Respondents had mixed reactions to the LSF. They were unable to relate the formal configuration of the device to the filter technology inside because it did not fit their mental model of a two-container filter (such as a Rama). They did appreciate the use of what they felt was “durable plastic.” Participants did not perceive the LSF as a consumer durable because its form appeared to be guided more by engineering and functional requirements than consumer preferences. A key concern among respondents was the capacity of the LSF. Most respondents and their family members felt that the water receptacle of the LSF needed to be much larger. They used existing household utensils as a reference and stated that it could be as big as a sarva (5 L) or a bindal (20 L).

Another concern shared by all households was the absence of a lid on the LSF. Respondents stated that since the upper receptacle of the LSF is a water storage unit, it should have a lid to protect the water from dirt, dust, and falling particles. They felt that new dirt and dust in the water will further contaminate the water and will clog up the filter. In two of three houses, a piece of cardboard was used as a makeshift lid.

Although most of the respondents did not understand the hollowfiber technology in the filter initially, they were confident that it would clean the water. But this perception changed drastically over the course of the EUT, as respondents later stated that the LSF had failed to work in their houses.

Setup and Assembly: Initial reactions to the LSF were that it was space-saving and convenient, but most respondents had difficulty finding an ideal location to hang it. None of the households put new nails in the walls of their houses because they did not have the tools or the house did not belong to them. The location for the LSF was decided based on the location of existing nails and not on accessibility to water storage utensils or ease of access. The LSF had to be placed at a height, and respondents had difficulty procuring a stool or platform while hanging the filter as well.

Use: Because the capacity of the LSF untreated water reservoir is very small, the filter was filled with water many times during the day. Respondents said they put water into the filter when they had a need for it. Peak usage was during the morning and during meals, when a member of the household would collect water in a lota for consumption by the family. Because the LSF requires constant attention during use, one respondent stated that they only used the filter during meals, as they did not have time in the mornings to fill and wait for filtered water. Most families were using the filter for planned activities such as cooking and eating and were consuming unfiltered water from the bindals during the day. None of the households were filtering and storing the treated water in vessels for later consumption. One reason for this was that the processing and flow rate was very slow and respondents felt it would take a long time to filter one bindal of water.

The height for filling and for dispensing from the LSF is not ideal, and only adults used the filter. Because the LSF was placed higher than eye level, most people were spilling

water while filling because they were unable to see when the upper reservoir was full. Respondents stated that the hollowfiber filter component had to be held in place when dispensing, and that the clean water pipe did not fit well with any of the household vessels available.

In the case of the tap, all the respondents initially mistook the red back-flushed water outlet as the outlet for clean water, since it was placed at the bottom of the filter. They had to be guided on how to dispense clean water from the tap and dirty water from the red pipe. Respondents stated that the flow rate of the tap was hard to determine, and they were unable to state whether the filter was working properly or was clogged. The very slow processing/flow rate was the main reason households discontinued use.

Cleaning and Maintenance: Most respondents failed to understand the function of the back-flush but continued to do as instructed. The LSF was cleaned once a day, wherein it was taken outside the house to the water source. Respondents stated that even after cleaning the filter they were unsure that the filter was clean, as there was no way to gauge cleanliness. They were concerned that there was more dirt and dust inside the filter engine, where they could not reach. While the LSF was initially perceived as a device that encouraged user modifications and customization, respondents felt that they could not even make small fixes as it was a sealed device. They also stated that while they knew that the filter had a finite life, they were unable to determine when it was time to discard the product. In all the houses, the product was abandoned before its stipulated life.

Rama Ceramic Candle Filter



Technical Specs: Capacity: 34 L total (17+17); cost: Rs. 1,500; filtration technology: ceramic candle filters (mechanical filtration).

The Rama Ceramic Candle Filter was placed in four households across rural, semi-urban, and urban locations.

Table 11. Placement of Rama Ceramic Candle Filter

Location Name	Kakarlapadu	Kondapaka	Hanumakonda	Annanagar
Family (income) person/month (p/m)	Ambedkar (Rs. 3,000-4,000 p/m)	Narsimachari (Rs. 5,000-6,000 p/m)	Annama (Rs. 4,000 p/m)	Bhikshapati (Rs. 4,500 p/m)
Type of location	rural	rural	peri-urban	urban
Water source	electric bore	tap from bore tank	hand pump government water tank	electric bore, government water tank
Number of family members	4	4	4	6
Family members under 6 years old	none	none	none	1 son, 2 daughters
Family members 7-14 years old	none	son	2 sons	none
Family members 15-59 years old	father, mother & son	father, mother & daughter	father & mother	father & mother
Family members 60 years old and above	grandmother	none	none	grandmother

We made five visits to these households—through summer, monsoons, and winter—and collected information through observation and conversations with respondents and their family members.

The Rama Ceramic Candle Filter and similar steel candle filters are iconic for home water filtration because of their widespread presence in the market and homes. Among all the filters placed, it was the most readily recognized by study participants. Respondents noted that the steel candle filter would commonly be part of the wedding trousseau along with other household items that are needed to start up a new house. In the larger sample set, the most commonly understood filter technology is the ceramic candle filter. Even after experiencing other filter technologies, respondents and their families referred to the clay pot and activated charcoal filter components of multistage devices such as candles.

Product Perceptions: The Rama filter received very positive initial reactions from respondents and their families because it was made of steel. They stated that the Rama was a simple, yet durable filter that fit in well in their kitchen and the rest of the utensils. The filter would not require special care but could be cleaned and maintained like the other steel utensils. Families with very young children stated that a steel filter was good because they would not have to fear breakage through misuse by their children.

While the ceramic candles were the most easily understood and universally accepted filter element, most respondents stated that they felt the candles were fragile and extra care needed to be taken while handling the filter during filling and cleaning, even though rest of the device was mostly steel. They felt that while there was a two-year warranty on the steel filter enclosure, it was the candles that should have come with some warranty considering their higher susceptibility to damage. Because most respondents purchase their steel utensils by weight, they were able to judge the cost of the product and felt that it was appropriate for the material used.

Setup and Assembly: Most respondents who had seen a similar filter earlier were able to assemble the filter quickly. It was noted that respondents and their family members took the most time assembling the candles. They stated that as the candles were fragile, and extra care had to be taken to assemble them. Furthermore, there was no indication of how much to tighten the screws in order not to break them. None of the respondents had a screwdriver at home and had to use what was available to screw the knob to the lid of the filter.

The Rama is the tallest of the filters placed; therefore, respondents took a little time to decide where to place it. In most houses, the filter was placed on a low wooden stool, to provide easy access for dispensing by all members of the family.

Use: In all households, water was poured into the filter in the mornings, when it was procured from the source. Water was usually poured into the filter by the head of the household, the spouse, or the son. Respondents stated that they would rinse the filter in the morning along with other kitchen utensils and fill it with one bindal of water. The capacity of the Rama was seen as “ideal” since respondents were able to judge it in relation to their usage and existing storage utensils like bindals. Most of the respondents noted more than one incident of overflow in the Rama filter and felt the need for a water level indicator.

All members of the household used the filter to dispense water. The filtered water was used for drinking and cooking. Water stored in steel utensils is perceived as being warmer than water stored in clay gharas (pots). During summer, some of the households removed water from the Rama and stored it in a clay ghara for consumption. Water was

dispensed by pressing the two-way tap down to fill small utensils like lotas and glasses and by raising the tap handle for a continuous flow to fill a sarva. In one house where young children were dispensing water from the filter, a respondent stated that prior to the placement of the filter, children were not allowed to dispense drinking water stored in bindals for fear of contamination.

Most of the users felt that the device needed a prefilter to remove the bigger dirt particles so as not to clog the candles and reduce their life. In one case, a respondent stated that if they could not procure water from their clean-water source for some reason, they would drink water from their washing water source but would not run it through the filter because that would damage the candles.

Cleaning and Maintenance: A common indicator for cleaning, stated by most, was noticing settled dirt and dust in the upper container as well as on the candles. Initially, most respondents stated that the filter was rinsed every day before the first fill and washed once a week. Over the later visits, it was noted that the frequency of cleaning had increased to twice per week. Respondents stated that the candles were getting clogged sooner, resulting in slower processing rates for filtered water. While the steel body was washed with soap like other household utensils, most homes soaked the candles in lukewarm water and then scrubbed them by hand or with a cloth.

We noted two cases of breakdowns. In both cases, respondents were not able to determine whether the candle was working or whether water was leaking through a crack in the candle. One respondent stated that if he noticed that the speed of the water dripping from the upper to the lower container was faster, he would know that the water was leaking through some crack.

Respondents were not able to indicate or judge when it was time to replace the candles. They stated that they would continue to use the filter as long as the candles were not broken and water flowed down to the lower container. They felt that the cost of the candles and the constant replacement was a big hurdle in purchasing the filter and its continued use.

AquaSure (Eureka Forbes)



Technical Specs: Capacity: 18 L total (9+9); cost: Rs. 1,800; filtration technology: multistage mechanical filtration and chemical disinfection. Cloth prefilter, carbon sediment block, bromide halogen disinfectant.

The AquaSure was placed in four households from May to December 2009.

Table 12. Placement of AquaSure

Location Name	Attapur	Maderam	New Ganj	Paddepandiyal
Family (income) person/month (p/m)	Mallapa (Rs. 4,000 p/m)	Venkatiyah (Rs. 2,500 p/m)	Shiv Kumar (Rs. x p/m)	Venkatiyah (Rs. 3,000 p/m)
Type of location	urban	rural	peri-urban	rural
Water source	government-treated water through pipe	bore water through tap near house	government-treated water tank	hand pump, agricultural bore
Number of family members	6	6	5	6
Family members under 6 years old	granddaughter	son	none	none
Family members 7-14 years old	granddaughters, grandson	son & daughter	none	none
Family members 15-59 years old	father, daughter	father & mother	father, mother, 2 sons & daughter-in-law	grandmother, father, mother, son, daughter
Family members 60 years old and above	none	grandmother		grandfather

In all households the AquaSure was perceived as a novel product with a unique visual form. Most respondents who were aware of the Pureit felt that the AquaSure was a simpler and cheaper version of the same product. Respondents stated that the product was aspirational and improved the “show” of their house. They also stated that the temperature of the water in the AquaSure remained constant throughout the year.

Product Perceptions: During the initial placement, most respondents considered the form of the AquaSure to be novel, though over a period of extended use they noted that it was difficult to remove dirt and dust from the many contours and crevices of the filter. Respondents felt that the filter tended to look shabby after a short period of time, even

though they cleaned and maintained it as instructed. Respondents had mixed opinions about the use of plastic in the AquaSure. They felt that the plastic imparted an undesirable smell and character to the water stored in it, but also that it kept the temperature of the water constant. Over extended use, respondents were able to attribute taste and textural qualities to the filtered water. They stated that the water from the filter was soft and *Patla* (thin, in texture).

Although respondents appreciated the combination of colors and transparency in AquaSure, most wanted more color options. Most indicated that a transparent upper container and a water level on the lower container were advantages for extended use because they made it easy to judge if and when the filter was working. Respondents did state that they thought the plastic of the Aquasure was brittle, and they feared it would easily break while moving and cleaning it.

Most respondents and their families felt that the filter assembly was very technical, and they found it hard to understand how it worked. The families were able to make sense of it once the researchers started referring to the cartridges as the “candles.”

Setup and Assembly: In all households, the filter was assembled by a man, the head of the household. Although the men were easily able to stack the containers during setup, they had difficulty assembling the whole filter. They felt that assembly was complicated due to the large number of components and connectors.

Most respondents were unaware of where the prefilter was supposed to be placed, whether above or below the lid. The majority of them looked at the manual for cues and indications but were unable to find any. During assembly, respondents were confused between the orientation of the carbon block and the bromide disinfectant because they had similar interfaces and made the mistake of swapping one with the other. They were also concerned about the similar filter components having different locking mechanisms.

None of the respondents were aware that the filter elements required an initial soaking procedure and had to be informed to do this. They did not understand why the elements had to be soaked for 30 minutes before fitting them in the filter.

Use: In all households, respondents and their families continued to follow their existing routine for procuring water, even after the placement of a filter. In most households, water was procured in the morning and immediately poured into the filter. Most respondents were filling the top container with three-fourths of one bindal. In one household, a smaller pot (*sarva*) was filled three times with water from a larger bindal and was used to fill the filter. The young child filling the filter stated that it was easier for her to lift the smaller pot, and she had a clear idea of how much water to pour in, since one filling was equal to three small pots. During extended use, most respondents stated that the capacity of the filter should be one bindal as it would be easier to manage vessels while collecting and filling.

Respondents felt that the water level indicator was advantageous for checking the status of the filtered water in the lower container. During our final visit to one household, we found some algae growth in the water level indicator because of the dead water that always collected in the pipe. This could lead to contamination of filtered water in the lower container.

Most respondents were satisfied with the time the filter took to clean and process the water. They felt that if the processing time was any faster, that would mean that the water was not getting filtered properly. The dirt and dust that settled on the prefilter was seen as the most evident indication that the filter was working, though even during extended use respondents and their families were unable to articulate the role of the other filter components.

Cleaning and Maintenance: Most respondents felt that the filter was working effectively but would start clogging if it was not cleaned regularly. Generally, respondents cleaned their filters once a week by dismantling the filter and cleaning its parts separately. They felt that cleaning improved the flow rate and made the filter last longer without having to take any extra effort. Care was maintained while cleaning the AquaSure, as respondents feared it would break easily. The head male of the household usually cleaned the filter.

Initially, respondents stated that cleaning the filter was confusing because all the parts had different cleaning protocols. Although the sediment block had to be back-flushed, the prefilter and the bromide disinfectant did not. With extended use, respondents did not complain of any issues.

Pureit (Hindustan Unilever)



Technical Specs: Capacity: 18 L total (9+9); cost: Rs. 2000; filtration technology: multistage mechanical filtration and chemical disinfection. Prefilter, compact carbon sediment trap, Germkill battery (NaOCl) and activated carbon polisher.

Table 13. Placement of Pureit

Location Name	Devarkadra	Venkatpurtanda	Selmijalatanda	Medchal	Kondapaka
Family (income) person/month (p/m)	Anjamma (Rs. 5,000 p/m)	Saali Bai (Rs. p/m)	Rukki Bai (Barter)	Srinivas (Rs. 4,000 p/m)	Swami (Rs. 3,500 p/m)
Type of location	peri-urban	rural	rural	peri-urban	rural
Water source	bore tank municipal tanker	electric bore	hand pump	government supplied water to their house	government tank to pipeline
Number of family members	7	6	16	3	4
Family members under 6 years old	son	none	none	none	none
Family members 7-14 years old	son	2 sons	sons & daughters	none	none
Family members 15-59 years old	grandfather, grandmother, mother, sister, brother	father, mother, 2 sons	grandfather, grandmother, 4 couples, 2 sons	mother & son	father, mother, son & daughter
Family members 60 years old and above	none	none	none	grandfather	none

We conducted five visits to each of these households. We accompanied one family to a shop in town to observe purchase of the filter and in another we replaced the filter when it ceased working after two month's use.

Among the placed filters, the Pureit was seen as the most aspirational product. The perceptions of respondents and their families toward the complexity of its form and technology made the Pureit a desirable consumer durable and a product outside the realm of their existing household objects. The Pureit has a high novelty factor, and most of the respondents stated that even though it does not fit their current lifestyle, they could show it off to their friends, neighbors, and relatives.

Product Perceptions: Glossy finishes, novel colors, and a combination of opaque and transparent plastic contributed to the Pureit's novelty. Most respondents felt that even the packaging was fancy. While the novelty factor was very high, respondents also stated that they would have to take special care while handling the device as they perceived the plastic of the Pureit was brittle and easy to damage. Over many months of extensive use by the respondents and their families, we noted drastic changes in the physical appearance of the filter. The clear plastic was fogged up because of scratches as well as the sediment deposition in the crevices of the filter.

We asked respondents and their families about their reactions to the workings of the filter and the technology. A perception common to most was that its appearance was similar to that of a complex machine. They also felt that since this machine had four filters working inside it, it was bound to clean the water better than other filters and that the water that would come out of the filter would be drastically different. All respondents stated that the filter assembly was highly complex and technical, and they did not understand its functioning. Most respondents referred to the filter technology as "candles." They were able to understand the functioning of the prefilter and the sediment block because they drew analogies between them and a piece of cloth or a candle.

When users first encountered the Pureit, they did not easily understand the function of the Germkill battery. During extended use, respondents were able to understand the component and assess its status.

Setup and Assembly: At first glance, respondents felt that setting up the Pureit would require help from someone intelligent and articulate with experience of complex products. In most households, children assembled the device. In one case where an elderly woman was assembling the filter, she felt that it was very complex and was unable to continue without assistance. During the assembly we noted that while the children were able to understand locking mechanisms like snap fits, elderly respondents had difficulty locking the polisher and the lid for the prefilter in their place. During setup, some respondents were able to stack the filter containers with ease. Because most of the parts came preassembled, respondents had no indication whether the assembly sequence was correct. Most people poured some water in the filter and waited for it to filter down to check if the filter was correctly assembled. They also looked through the manual or the quick-start guide to find other indications that the filter was working correctly.

Respondents who tried to read the manual and the quick-start guide had difficulty understanding the information. They were looking for information on basic procedures

such as assembly and cleaning and were unable to understand the visuals. Most respondents searched the information on the packaging to find cues.

Use: Respondents and their families continued to use the same water source to fill the device. Women generally filled the devices while they took care of other household chores. Most respondents initially stated that the capacity of the filter was adequate, but during later visits, they suggested that it should be larger and accommodate one bindal per filling. Everyone in the family accessed the filter to dispense water for consumption. In most households, water was used only for drinking, but in the case of one family of three, water was used for cooking and preparing tea as well.

Most respondents were satisfied with the processing rate. Although a faster rate would be beneficial, they currently had no need for it. After filling, it took approximately 15 minutes for the water to start collecting in the lower container of the filter. We asked respondents about indications that the filter was working correctly. The drastic changes in the prefilter, in the form of clogging and discoloration, were perceived as the most evident proof of the filter's effectiveness.

Cleaning and Maintenance: Most respondents stated that they cleaned the filter once every week. In one household, the filter began to slow down in its sixth week of use, so the respondent started cleaning the filter every other day. In all households, a clean zone or surface was created for placing the components of the filter while cleaning it. In most households, the women responsible for filling the filter were also in charge of cleaning it. They stated that while cleaning the plastic containers was easy, cleaning the prefilter and the carbon block was tedious. They also felt that there was no indication, other than a dirty prefilter and settled dirt in the containers, when to clean the rest of the filter and its components.

Because most respondents believed that the replacement cycle for the filter engine was based on time, they were unable to understand why their filter battery was exhausted before its due time even though they cared for and maintained the filter as suggested. None of the households purchased replacement batteries because they did not have enough money, and shops that sold the components were too far away.