User Perspectives on Water Reuse: Insights from Urban India

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Create a waste treatment and toilet system that is ...

1. “Off-grid”. Does not require an external source of electricity, water or sewer

2. A waste treatment system treats all pathogens on-site

3. An affordable system operating on no more than 5 cents per person / per day

4. An aspirational waste treatment & toilet system with appeal for developed and developing countries applications
Data from India field testing of two RT technology grantees. Insights from user studies on water reuse, a key value proposition for the 2 technologies.

1. Duke – RTI WiC toilet and waste treatment system testing in Ahmedabad, Gujarat  
   - Shared or public toilet block treatment system  
   - On-site treated liquid is recycled

2. Kohler CLASS system field testing in Coimbatore, Tamil Nadu  
   - Apartment block waste treatment system  
   - On-site treated liquid is recycled
User insight research focuses on the interaction between technology and human behavior

Field testing user insight research examines stakeholder perceptions, knowledge, and behaviors and the implications of these for technology adoption and sustained use.

Questions include:
• How do users understand and interpret the value of the system?
• What factors (+/-) affect the user experience?
• What perceptions and behaviors change during the course of interactions?
• What implications do these hold for future adoption of the system?
Methods: Insights from Gujarat

1. Household survey (1,213 HH) of urban slums in Ahmedabad, Gujarat
   • Stratified by primary facility used, religion, community size
   • Low-income households randomly selected; delivered to M/F primary decision makers
   • Understand sanitation practices and preferences
   • How users evaluate features of system

2. Focus Group Discussions (92 FGDs) at prototype sites in Vadodara and Ahmedabad
   • Low-income household participants (+910 people)
   • Grouped by age, religion, M/F/mixed gender groups
   • Themed discussions around women and men’s use patterns, MHM, water reuse, on-site treatment

3. User feedback at prototype
   • Rapid user survey post-toilet use (+220 surveyed)
   • Users: students, street vendors, construction workers
Reuse Applications

- **Flush water**
  - High acceptance, when no direct contact of reused water

- **Anal cleansing**
  - Views on recycled water for anal washing preferred to use in handwashing
  - Mixed acceptance: men widely accept, women/mixed-gender groups express some concern about water’s purity for self-cleaning

- **Hand-washing**
  - Concern about water purity: many suggested use, and “re-wash” necessary (e.g. before eating, before praying)

- **HH / community uses**
  - Varied willingness to use recycled water for bike washing, clothes washing, irrigation, household cleaning
  - Taboos on use of impure water widely vary (e.g. no use on items that bring money, living things, before prayers)
Key Take-aways

User Insights:
• Water access at the toilet is driver for use
• Water conservation is valued, especially in water stressed communities
• Water reuse is very viable, not a “show-stopper” in RTs
• Water reuse is a value-addition for future products
• Socio-cultural factors vary and influence re-use scenarios

Lessons for our further technology development:
• Appearance, color, odor important focus
• Presence of modest chlorine smell is viewed positively
• Steps for further polishing water for clarity underway
Kohler CLSASS system
User insight from field testing in Tamil Nadu
Overview of CLASS Technology

Closed Loop Advanced Sanitation System

CLASS Prototypes were built by Kohler in Pune, India

- Multi-family, blackwater processing unit
- Anaerobic settling tank pretreats waste
- Electrochemical oxidation converts chloride to produce chlorine, a pathogen killing disinfectant
- Water re-used for toilet flushing
Field testing in Coimbatore, Tamil Nadu

Features of Testing Site:

- Location: Serene Senior Living apartment complex
- Domestic toilet use
- Unit connected externally to 3-5 apartments, ~20 users
- Sewage connection to system to ensure *no* disruption in water or wastewater services to the residents

181 Days of operation in closed loop

100,000+ Volume of waste water treated (L)

< 1 E.Coli (cfu/ml)
Insights are captured during field testing to understand the change in stakeholder attitudes and behaviors over time.

- Pre-baseline: 3-4 months before loop closes
- Baseline: 2-3 months after first loop closure
- Endline: 6 months after loop closes

Pre-intervention behaviors/attitudes/beliefs

Initial adoption behaviors/attitudes/beliefs

Sustained use behaviors/attitudes/beliefs
Initial insights draw on structured qualitative interview data with resident “users” of the CLASS system.

Technical approach and analysis

**Pre-baseline:**
- Focus: documenting standard household behaviors: e.g. water use, sanitation, cleaning
- Methods: Observation, facility mapping, and informational interviews with users and facility managers
- Data collection, QC, and analysis conducted by Quicksand (Bangalore-based qualitative research firm)
- Conducted in Tamil and Hindi

**Baseline:**
- Focus: system perceptions and understanding, related changes to user behavior and attitudes after initial exposure to system
- 12 interviews conducted with 14 residents of Serene employee residences, including family and “bachelor” residences
- Methods: Structured interviews conducted by Coimbatore-based qualitative research firm, Market Eye
  - Trained by Quicksand and introduced to residents via STeP field team
  - Interviews conducted in Tamil
- STeP Field team conducted QC of data
- Analysis conducted by RTI

**Endline:**
- 6 months after loop closes
• Initial insights draw on structured qualitative interview data with resident “users” of the CLASS system.

• Technical approach and analysis

Pre-baseline: 3-4 months before loop closes

Baseline: 2-3 months after first loop closure

Endline: 6 months after loop closes

Pre-intervention behaviors/attitudes/beliefs

Initial adoption behaviors/attitudes/beliefs

Sustained use behaviors/attitudes/beliefs

• Endline:
  • Focus: changes in system perceptions and related changes to behavior/attitudes after sustained use of system, long-term impacts within and beyond household
  • Data collected in late October-early November 2016
  • Methods: in-depth structured interviews conducted with 6 residents, role-play session conducted with 4 residents
    • Role-play sessions involved participants acting out scenarios associated with new system
    • Data collection, QC, and analysis conducted by Quicksand; methods development overseen by RTI
    • STeP Field team conducted QC of data
  • Interviews conducted in Tamil
User insights research used a mixed methods approach to collect data throughout the field test.

**METHODS**

Residents were given calendars to note system-specific events or issues to help with memory recall during in-depth interviews.

**Structured interview guides** were developed by RTI with input from Quicksand and adapted to specific questions of CLASS system.

**Facility maps**, built through walk-throughs with the facility manager, illustrates key points of interaction between the exiting waste management system and its stakeholders.

**Role-plays**, where users act out their perceptions and reactions, were used with residents to aide with respondent fatigue.
Users see system as a wholly positive addition to their households and community.

- Users see the CLASS system as aspirational, innovative, and safe:
  - The automatic flush was new and seen as a modern amenity to several users
  - Sharing information about the system with external guests, friends was common and often detailed as a source of pride.
- Before commissioning, concerns that the system would affect the health of the users were common; no users voiced these concerns at the completion of the six month field test.

“...I haven’t seen like this anywhere outside, this is new, this is nice.”

“As far as we are concerned, we are much satisfied with this, even if guests come to our home means we take them to it and show how it is getting cleaned...”
Interactions increase awareness of water scarcity and need for conservation

- At Serene, no users pay for the water that they use and water supply for drinking and household use is always available, but many have experienced water scarcity previously.
- Users note that the CLASS system’s water conservation was a primary benefit. Residents demonstrated high awareness to small-scale water conservation, a feeling which draws on experiences of water shortage and a macro climate of regional or global water scarcity.

“\textit{One of the main positives of this system is its ability to reuse the water. Because of it, my water consumption while using the toilet has reduced...}”

“In Chennai you don’t get water. That situation might come here.”
**Toilet behaviors that introduce water into the toilet – such as flushing – remain largely unchanged.**

- Users detail that behaviors that introduce water into the toilet cistern include: flushing, cleaning, anal cleansing, and bathing. Tap water, not treated water, is used predominantly for cleaning, bathing, and anal cleansing.

- Flushing behaviors have changed somewhat over the course of the field test, partially due to the addition of an auto flush.

- Several users were asked at endline to report any change in flushing habits: those who previously used three buckets for flushing, now use one flush and one bucket (after use) for cleaning.

- The practice of pouring extra water after or before a flush to “clean the bowl” – either from a bucket or with an additional flush - has not changed. This practice is more common among shared, non-family households (e.g. a “bachelors flat”) and households with children who seek to keep the space clean.

- Before the CLASS system was installed users expressed resistance to changing the cleaning practices of the toilet space and these have not been reported as changed throughout the field test.

> *Earlier we pour 3-4 [small] buckets [after use], whereas now we can pour 1 or 2 buckets and use the flush water for cleaning the toilet*”
Odor and appearance are key factors determining user acceptance of the treated water.

- The importance of smell and appearance (e.g. turbidity, color) were consistent factors that residents used to judge the water quality.
- Many users felt the treated water appeared and smelled better than the STP water that they use regularly. Familiarity and some bad experiences with STP water in the past gave some users initial concern, however smell and clarity of water distinguished treated water and STP water over time.

"The STP water is not very clear. But what disturbs me is the smell... I wouldn’t use it for my toilets or garden because to me it isn’t clean water."

“I am very surprised to see the treated water pure and clear as RO water. It’s hard to believe.”
Trust in the system was built through consistent quality of the treated water over time and external guarantees.

- Even initially skeptical users felt that treated water, judged by smell and appearance, were consistent and always available during the CLASS field test. Given the importance that households put on water supply, linked closely with health and hygiene, this reliability was highly valued.
- External guarantees additionally boosted user acceptance and willingness to use treated water:
  - STeP field team’s consistent presence on the site gave users confidence that the system’s function and its water output were being closely monitored and cared for. Residents felt comfortable sharing concerns or issues with technicians.
  - Town hall information sessions conducted with residents before commissioning were frequently cited as key points for users to receive information and ask questions, which helped to build trust.
  - Presence of “foreign” engineers gave some users the sense that the system was important and carefully monitored for quality.

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“There is always some technician on site. If I notice anything unusual about the water, I inform him.”

“Foreigners came [to explain]. They used to hold small meetings and tea parties.”
Perception of chlorine, when present in moderation, is largely positive.

- When the loop was initially closed, some residents recalled extreme chlorine smells coming from the treated water and toilet area. While all users are familiar with the smell of chlorine from common cleaning products, users had mixed attitudes towards the intense chlorine smell. Several users felt it signaled cleanliness, others felt it might be damaging to health.
- Users report that chlorine smells have decreased significantly since the system was first commissioned. Nearly all say that when the smell is moderate, it is seen as clean and helps to mask odors in the toilet.
- Users suggest that a mild chlorine smell is not harmful and may have additional benefits, such as keeping insects away.

“\textit{In our village in drinking water they will add chlorine... So we are used to it.}”

“\textit{About two months ago, I noticed a very heavy chlorine smell in the treated water and raised a complaint. I think since that time, I have noticed the smell to be not so strong.}”

“\textit{There are so many mosquitoes in our house, but there aren’t many in the toilet. I think they don’t like the chlorine smell.}”
Overall Take-aways from the Two Systems

- Water reuse is viable, not a “show-stopper” in RTs
- Water access at the toilet is driver for use
- Water conservation is valued, especially in water stressed communities
- Appearance, color, odor important focus
- Presence of modest chlorine smell is viewed positively
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