

Understanding Sanitation Preferences

***A Human Centered
Approach to Tackling
India's Open Defecation
Crisis***

University Honors Program Thesis

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Executive Summary

Unsafe sanitation contributes to an enormous public health crisis, particularly in India, which possesses the world's highest number of people practicing open defecation. Despite the efforts of the government and NGOs to tackle this issue, millions of toilets still go unused across India because they fail to meet the needs of users. Human-centered design provides an opportunity to ensure that sanitation solutions are utilized by placing the user at the center of the design process. To better characterize the design features of a desirable toilet, I began the first step of the human-centered design process: understanding the needs of the end user in November 2017. Working alongside two NGOs in the Sirohi district of Rajasthan, I conducted semi-structured group (n=8) and individual interviews (n=40) with community leaders, village residents, government officials, and NGO workers, in addition to observing 36 household latrines. In this study, 78% of respondents did not use their toilets due to design-related flaws, demonstrating the need for more human-centered design. Instead, participants expressed the desire for an odor-free latrine that requires little water, is large enough to comfortably sit in. For both governments and NGOs alike, human centered design thus presents opportunities for increasing the effectiveness of sanitation programs through a greater understanding of user needs and greater user feedback.

Glossary of Abbreviations and Non-English terms

Below-poverty-line (BPL) = economic benchmark used by the government of India to identify households in need of government assistance

Biodigester = toilet that digests organic waste matter through bacteria

Centre for Microfinance (CMF) = host organization

Community resource person = community worker employed by the Centre for Microfinance to educate people about health topics like sanitation, early initiation of breastfeeding, and maternal nutrition

Dalit caste = member of lowest caste grouping in India; also known as the “untouchables”

Hamlet = small settlement of houses, generally smaller than villages

Jan Chetna Sansthan (JCS) = host organization

Kaccha/i = a term used to describe housing structures made of less permanent materials, like mud or earth

Gram panchayat = administrative unit classification in India; areas are defined by state, district, block, panchayat, ward, and village

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) = an Indian labour law providing at least 100 days of wage employment per year for households in rural areas

Swachh Bharat Mission (SBM) = a campaign aiming to end open defecation in India by 2019

Pakka/i = a term used to describe housing structures made of more permanent materials, like cement or wood

Pradhan = village leader

Rupee (Rs) = the Indian currency; at the time of writing, 1 US Dollar equaled 64.48 rupees

Sarpanch = head of the panchayat

Secretary = non-elected representative appointed to oversee panchayat/block/ward activities

Self-help group = informal groups of people who gather to improve their living conditions, typically through collecting and pooling savings from each member in the group

Superstructure = the outside walls of a toilet

Sub-structure = the inside components of a toilet, including the pit, pipes, and pan

Toilet pan = the bowl of the toilet for squatting on

Vermicompost = term used to describe composting using worms

Ward panch = elected ward representative

WASH = a collective term for water, sanitation, and hygiene, grouped together to represent an interconnected sector

Introduction

The Problem of Poop

A lack of adequate sanitation is driving an enormous public health crisis worldwide. Open defecation is the practice of going out to defecate in open fields or any space that does not hygienically separate fecal matter from human contact, and approximately 892 million people worldwide currently defecate in the open.¹ This is problematic because poop carries harmful passengers; 1 gram of human fecal matter can contain up to 50 communicable diseases, 1 million types of bacteria, and 10 million viruses. By contaminating water sources and transmitting pathogens via fecal-oral mechanisms, open defecation spreads waterborne and diarrheal diseases like cholera, rotavirus, and hookworm.

Young children especially bear the brunt of this burden; diarrheal diseases are the 2nd largest killer of children under 5 worldwide.² Beyond these high mortality rates, children who experience frequent episodes of diarrhea are also more vulnerable to malnutrition, stunting, and other diseases due to a weakened immune system and an inability to absorb adequate nutrients.³ This leads to child stunting, which has been associated with reduced learning in schools and lowered adult economic productivity.⁴

Nowhere else is the burden of open defecation felt more strongly than in India, which has the highest number of people openly defecating in the world. Approximately half the population continues this practice; additionally, diarrheal diseases are the third leading cause of death in the country.^{5,6} Beyond these immediate health consequences, the widespread prevalence of open defecation has long-term economic impacts: the World Bank estimates that India loses \$53.8 billion yearly, or the

¹ World Health Organization, "Sanitation," last modified July 2017, <http://www.who.int/mediacentre/factsheets/fs392/en/>.

² Center for Disease Control, "Global Diarrhea Burden," last modified 17 Dec 2015, <https://www.cdc.gov/healthywater/global/diarrhea-burden.html>.

³ Diane Coffey et al, "Understanding Open Defecation in Rural India: Untouchability, Pollution, and Latrine Pits," *Review of Rural Affairs* 11, no. 1 (January 2017).

⁴ Coffey and Spears, *Where India Goes*, 128-155.

⁵ World Health Organization, "Sanitation."

⁶ Institute for Health Metrics and Evaluation, "India," last modified 2016, <http://www.healthdata.org/india>.

equivalent of 6.4% of its GDP from the combined economic losses of premature deaths, recurrent costs of disease treatment, and reduced economic productivity.⁷

Past Sanitation Efforts and the Issue of Unused Toilets

Many entities realize the health and environmental dangers of poor sanitation and have worked to address the problem. Traditionally, the main players within this space have been the Government of India, international non-governmental organizations (NGOs), and smaller local NGOs.

Since 1986, the Government of India has spent over \$3 billion dollars constructing toilets, with limited results. Past programs like the Central Rural Sanitation Programme (1986), the Total Sanitation Campaign (1999), the Nirmal Gram Puraskar (2003), and the Nirmal Bharat Abhiyan (2012) were mainly subsidy-based, fully or partially covering the costs of toilet construction for poor households. However, these programs did little to educate end users about the importance of sanitation or solicit feedback during the process of toilet construction.

Large international NGOs such as WaterAid, the Gates Foundation, and Habitat for Humanity have also financed the construction of toilets through contracts with local NGO service providers. NGOs like UNICEF have also taken a capacity-building approach, training facilitators to hold workshops on the importance of sanitation. Finally, smaller community-based NGOs, typically funded by grants or charitable donations, have also delivered sanitation services – though on a smaller scale.⁸

At the same time, many of these efforts – whether through government or NGO – have gone wasted, as millions of toilets sit unused across India. In 2013-2014, researchers at the Research Institute for Compassionate Economics (r.i.c.e) conducted an independent survey of Sanitation Quality, Use, Access, and Trends (SQUAT) in 3,235 households in rural areas of the Indian states of

⁷ Water and Sanitation Program, "Inadequate Sanitation Costs India the Equivalent of 6.4% of GDP," n.d., <https://www.wsp.org/features/events/features/inadequate-sanitation-costs-india-equivalent-64-cent-gdp>.

⁸ Shyama V. Ramani, Shaun SadreGhazi, and Geert Duysters, "Taking innovation to the poor: Lessons from sanitation activists in India," *Georgia Institute of Technology*, 2009. .

Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh, and Haryana.⁹ Through their survey, they found that over 40% of the households they sampled had working latrines but nevertheless had at least one family member defecating in the open.¹⁰

The need to develop more effective sanitation programs is only heightened because of the current Swachh Bharat Abhiyan, or “Clean India” Mission (2014), which has brought sanitation to the forefront of the national agenda. This initiative boldly aims to end the practice of open defecation, building a total of 120 million toilets by 2019. To support these efforts, the government will spend a record \$31 billion dollars, which is 40 times the amount that India has invested in developing a satellite to orbit Mars.¹¹

But what if these billions of dollars simply result in more unused toilets? To prevent more sanitation efforts from being wasted, we must first work to understand the reasons why Indian households aren’t using their toilets.

Researchers at r.i.c.e. hypothesize that many of these toilets go unused because they fail to meet the needs of their users. In their sanitation study, researchers Diane Coffey and Dean Spears describe the case of Sohni Devi, a resident in western Uttar Pradesh, to better illustrate this concept. Though Sohni had a working latrine, no one but her two small children, aged five and seven, used their toilet and were using it temporarily until they were old enough to go out and defecate on their own. When asked why she, her husband, and mother-in-law did not use the latrine, she commented, “The pradhan (village leader) made this [latrine]. If we’d made it, we’d have made it the way we wanted.”¹² Her statement demonstrates that current sanitation programs are not building toilets according to the preferences of their end users, which results in abandoned toilets.

⁹ Diane Coffey, et al., “Revealed Preference for Open Defecation: Evidence from a New Survey in Rural North India,” *Economic & Political Weekly* 49, no. 38 (September 2014): 43-59.

¹⁰ Coffey and Spears, *Where India Goes*, 43.

¹¹“Why it’s easier for India to get to Mars than to tackle its toilet challenge,” *The Conversation*, 18 Nov 2016, <https://theconversation.com/why-its-easier-for-india-to-get-to-mars-than-to-tackle-its-toilet-challenge-69015>.

¹² Coffey and Spears, *Where India Goes*, 65-66.

Accounting for Consumer Preference: The Rise of Social Entrepreneurship

Social entrepreneurship presents an alternate strategy for delivering more utilized sanitation solutions, using the traditional principles of entrepreneurship to serve undeserved, neglected, or highly disadvantaged populations.^{13,14} In 2004, C.K. Prahalad wrote about the opportunities that lay in creating new business models that sold to the poorest people in the world, those typically overlooked because they were at “the bottom of the [financial wealth] pyramid.” He hypothesized that the size of this segment, approximately 4 billion people, would entail a large enough untapped market to denote a substantial business opportunity for companies while providing essential goods and services. Thus, instead of viewing the poor as beneficiaries typically requiring charity from governments and NGOs, businesses could see them as valuable potential customers whose needs should be catered to.¹⁵ Additionally, charging the poor for a valuable product or service allows them to become customers with the ability to complain, rather than being “passive, grateful recipients of charity.”¹⁶ This process of feedback ensures that sanitation solutions fully address user needs, as customers will not buy a product that doesn’t serve them.

The Sustainable Sanitation Alliance believes in the power of launching such sanitation business models that would target “the bottom of the pyramid.” Though they note that the poorest of the poor, those making under \$1.17 or 77 rupees a day, might be best served by sanitation subsidies, they argue that there is a sizable population with a daily income of \$1.17 to \$6.65. Though this income bracket certainly wouldn’t be making enough to be considered wealthy, the Sustainable Sanitation Alliance argues that this population already has a disposable income that is currently being spent on other nonessential goods, like mobile phones or televisions. In fact, currently more Indians own mobile phones than toilets. If businesses were launched to specifically meet the needs of this

¹³ Roger L. Martin and Sally Osberg. "Social Entrepreneurship: The Case for Definition," *Stanford Social Innovation Review*, 2007.

¹⁴ J. Gregory Dees, "The Meaning of "Social Entrepreneurship," Duke Innovation and Entrepreneurship, 2014, accessed February 26, 2018, <https://entrepreneurship.duke.edu/news-item/the-meaning-of-social-entrepreneurship/>.

¹⁵ C.K. Prahalad, *The Fortune at the Bottom of the Pyramid* (Wharton School of Business, 2004).

¹⁶ J. Gregory Dees, "A Tale of Two Cultures: Charity, Problem Solving, and the Future of Social Entrepreneurship," *J Bus Ethics* 111 (2012): 321-334.

segment, local communities and individuals might be more motivated to purchase and use sanitation solutions.¹⁷

In response to these needs, numerous organizations such as Svadha and Banka BioLoo have launched sanitation-focused social enterprises. Believing that local residents are best suited to determine the needs and desires of their customers, Svadha recruits local entrepreneurs to sell different packages of sanitation solutions, ranging from basic latrines to eco-toilets. Alternatively, Banka BioLoo installs an innovative toilet technology which utilizes bacteria to digest human waste in schools and railways, reducing odors and the need for continual waste management. Both of these enterprises have delivered significant impact: Svadha has trained 300+ entrepreneurs to deliver 24,000+ sanitation packages in the Indian state of Orissa since 2013, and Banka BioLoo was the first sanitation enterprise to undergo an initial product offering in 2018.^{18, 19, 20, 21}

However, not everyone can be served by these kinds of social enterprises, which mandate that individuals have the disposable income to purchase their own sanitation solutions. Nonetheless, open defecation is still remains a public health issue that governments and NGOs must continue combatting to prevent the spread of disease. Human centered design presents another method of ensuring that sanitation programs are accountable to the needs of end users.

¹⁷ "Sanitation as a business," Fact Sheet, Sustainable Sanitation Alliance, April 2012.

¹⁸ Ambika Behal, "Meet the Toilet Company That Thinks It Can Fix India's Sanitation Problem," Forbes, 24 Nov 2016.

¹⁹ "About Us," Svadha, accessed 26 February 2011, <http://svadha.com/>.

²⁰ Sanjay Banka, Phone Interview, 26 Sep 2017.

²¹ Sanjay Banka, Individual Interview, 12 Nov 2017.

Human Centered Design and Sanitation

Human centered design is an iterative design process which puts the user at the center of the design process. As the infographic below demonstrates, the first step of this process involves understanding the problem by putting the designer in the shoes of the user. Through observing users, conducting interviews, and other research techniques, the designer is able to better define and empathize with the exact pain that the user is facing. The designer then explores solutions by ideating and generating a series of rapid prototypes. As these prototypes materialize, user feedback is sought at each stage and even after implementation to further refine the design. The iterative nature of design process ensures that solutions actually address the needs of users.²²

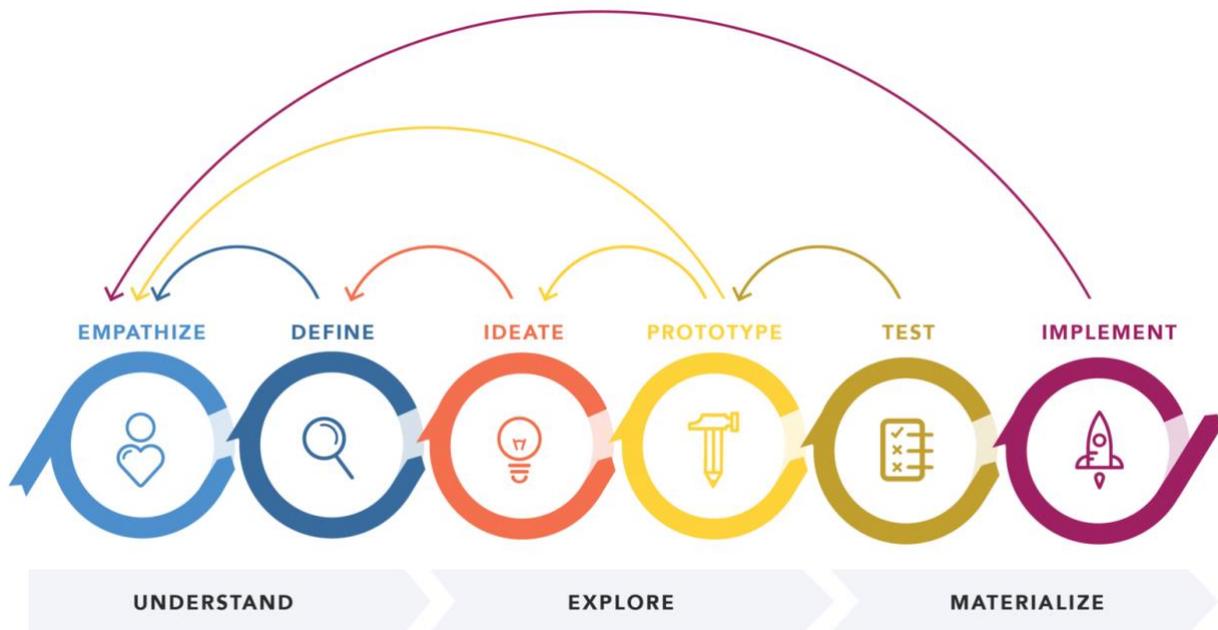


Figure 1: Diagram of Human-Centered Design Process.²²

²² "Design Thinking 101," Nielsen Norman Group, 31 July 2016, <https://www.nngroup.com/articles/design-thinking/>.

During the course of a semester-long study abroad program in India, I had the opportunity to begin one of the first parts of the human-centered design process: understanding the needs of the end user. Through the facilitation of two local NGOs, I explored the reasons that available latrines went unused in a rural district of Rajasthan, India and characterized the features of a desirable toilet. This paper summarizes the design insights that I gathered, along with suggestions for how human-centered design could be better integrated into sanitation programs.

Background

Study Site

Rajasthan is India's largest state, bordering Pakistan on the northwestern side of the country. Due to its size and sparse distribution of the population, certain groups, particularly those in rural areas, are difficult to reach in terms of providing basic services, leading to some of India's lowest human development indicators.²³ For example, literacy rates in Rajasthan are the 3th lowest in the country and are lower for girls.²⁴ Maternal and infant mortality rates are among the highest in the country, though they have been decreasing in recent years. Additionally, its geography poses challenges too: with 60% of its total land area being considered desert, groundwater in many areas of the state is also unfit for human or livestock consumption, and agricultural livelihoods, which make up a majority of jobs in the state, remain vulnerable to droughts.²⁵ These factors have resulted in some of the lowest life expectancies in the country—in 2014, life expectancy was only lower in 6 of India's 29 other states.²⁶

Despite this, sanitation coverage has rapidly increased in Rajasthan. In 2012, the government commissioned a comprehensive baseline survey (BLS 2012) that showed that access to sanitation in

²³ *Rajasthan Human Development Report 2002*, Report, Rajasthan: United Nations Development Programme, 2002.

²⁴ *Status of Literacy*, Report, Government of India, 2011, http://censusindia.gov.in/2011-prov-results/data_files/mp/07Literacy.pdf.

²⁵ *Rajasthan Human Development Report 2002*, United Nations Development Programme.

²⁶ *Abridged Life Tables 2010-2014*, Report, Government of India, 2016, http://www.censusindia.gov.in/Vital_Statistics/SRS_Life_Table/2.Analysis_2010-14.pdf

rural Rajasthan was 27.2% compared to 38.7% in the rest of rural India.²⁷ As of March 2017, 55% of Rajasthan has been considered open-defecation free, showing a large increase from 2012.²⁸

However, tribal populations remain one group to focus on in terms of sanitation. Making up approximately 8.2% of India's total population (2011 Census), these groups are the original inhabitants of the land but have been historically exploited for land, labor, and natural resources. Today, 573 of these communities are recognized by the government as "Scheduled Tribes" that are eligible for special benefits and reserved seats in legislatures and schools, but high levels of poverty, low literacy rates, and poor health indicators still remain.²⁹ Particularly, sanitation promotion in the southern tribal areas of Rajasthan has been difficult due to geographical isolation, making outreach and transport of supplies difficult. Furthermore, open spaces for defecation are common in hilly tribal areas, diminishing the need for a toilet, and water scarcity makes usage of toilets difficult. Invoking conventional motivators like shame and pride for poor sanitation has also been reported to be not as effective with tribal groups.³⁰

For these reasons, I chose to focus on understanding the sanitation needs of tribal groups in the Sirohi district, a semi-desert and hilly district in the southwestern part of Rajasthan. The Sirohi district is part of the Southern tribal belt of Rajasthan, where there is a large tribal population and the highest rural poverty rates in the state.³¹ During the course of my study, I worked closely with two NGOs: Jan Chetna Sansthan (JCS), a tribal, rural, and women's development NGO that had been working in the area for 22 years and the Centre for Microfinance (CMF), an NGO working on water and sanitation programs in the area. More information on both of these organizations is included in the Appendix.

²⁷ *Rajasthan Sanitation Journey 2011-2017*, Report, UNICEF, 2017.

²⁸ *Rajasthan Sanitation Journey 2011-2017*, UNICEF.

²⁹ Virginius Xaxa, "Protective Discrimination: Why Scheduled Tribes Lag Behind Scheduled Castes," *Economic and Political Weekly* 36, no. 29 (July 2001), 2765-2772.

³⁰ *Rajasthan Sanitation Journey 2011-2017*, UNICEF.

³¹ *Rajasthan Human Development Report 2002*, United Nations Development Programme.

Methods

Semi-structured group (n=8) and individual interviews (n=40) were conducted with community members, government officials, and NGO workers over the course of three weeks. To understand the current state of sanitation in the community, individual interviews were conducted with NGO workers and government officials using a semi-structured interview guide to triangulate responses (Table 2). In group and individual interviews, questions were divided into three major themes: (1) community or individual sanitation practices, (2) sanitation beliefs, and (3) toilet design preferences. Additionally, observation of 36 household toilets was performed using a structured observational guide to understand toilet history, usage, and design type. Finally, visits to an eco-toilet manufacturing facility in Alwar, Rajasthan and a World Bank-sponsored park showcasing different models of toilets in Pali, Rajasthan were undertaken to better understand suitable toilet designs for rural populations in Sirohi. A full listing of interview questions is found in the Appendix.

Table 1: Research questions and research methods for collecting data to answer each question.

Research Questions	Methods
What is the current state of sanitation in the community?	Individual interviews with NGO workers, key community leaders, government officials, and group interviews with community members
What are motivations and barriers to toilet usage?	Individual and group interviews with community members
What are the design specifications of a minimally usable toilet?	Individual and group interviews with community members

Ethics

To uphold the decision-making ability of each individual, consent was obtained before each interview and observational visit. Brief background on the study was provided, and participants were informed of their ability to skip any of the questions or discontinue the interview at any time. Participants were also told that there were no rewards for participating or costs of withdrawing for the study; however, several participants still requested help in obtaining improved water or sanitation infrastructure. Though this statement was reiterated, some participants may have skewed answers, believing that there would be special rewards, such as increased sanitation investment in the community, as a result of their responses.

To protect the privacy of all interviewees, all names mentioned in this study are changed from their original ones, especially due to the increased consequences for those practicing open defecation under the current Swachh Bharat Mission (SBM). In certain parts of Rajasthan, extreme penalties such as the disconnection of local power supply and the denial of work under the Mahatma Gandhi Rural Employment Guarantee Act (MNREGA) have been instituted for those not owning toilets.³² For the purposes of security, all names mentioned in this study do not indicate the real name of the interviewee. Additionally, questions in the interview guide were specifically worded to avoid directly asking a person whether he/she practices open defecation. At the same time, due to the pressure of SBM, it is also fully possible that respondents may have falsely answered questions regarding open defecation practices. To combat this, when interviews were conducted at households, answers regarding toilet usage were triangulated with toilet observation with the permission of the owner. Permission was also requested before taking any photographs, and the full script used to request consent from interviewees is provided in the Appendix.

³² "Using Threats, Arrests, and Benefit Cuts, Rajasthan is Pushing Through the Swachh Bharat Mission," *The Wire*, 7 Sept 2017, <https://thewire.in/174871/rajasthan-swachh-bharat-open-defecation/>.

Sampling Method

Ten villages in the Abu Road (n=6) and Pindwara (n=4) blocks were visited over the course of three weeks. Seven of these villages were accessed by accompanying JCS staff on routine field visits. The remaining three villages in the Pindwara block were recommended by CMF and were visited with the assistance of field workers. Within villages, interviewees were recruited through a snowball sampling method, in which interviewees are recommended by other participants or contacts, creating a “snowball effect.” Typically, interviewees were community members known by the NGO or households recommended by community leaders.

This sampling design was largely based on the availability of the two NGOs as well as those present when were in the village. Furthermore, due to the difficulties of finding transportation to villages, areas visited were typically within walking distance (2 miles) of town areas, as shown by the map in the Appendix. Ultimately, these methods have distinct limitations, as this is by far not a representative sampling of all households in the 78 villages in Abu Road and 96 villages in Pindwara.³³ However, for the purposes of an exploratory study, these methods were considered most feasible for the limited time frame of conducting this study.

Data Analysis

Recordings of each interview were taken and analyzed afterwards with the help of a translator. In order to best triangulate responses across all interviewees, answers to questions in the semi-structured interview guide were noted down after interviews. For closed-answer questions (yes/no), descriptive statistics were compiled. Within group interviews, individual responses to closed-answer questions were also included in the statistical analysis. For open-ended questions, common themes across all interviews were grouped and categorized. To provide a fuller understanding of the

³³ *Status of Declared and Verified ODF Villages*, Ministry of Drinking Water and Sanitation.

sanitation context in these villages, qualitative case studies were also compiled to give better voice to certain perspectives.

Not all questions were able to be asked in every interview; interviews varied in length and content depending on the context. Additionally, due to the language barrier and need for a translator, it is possible that questions and responses may have been inaccurately worded. Accordingly, the data represented is neither representative of all the interviewees in this study nor the Sirohi district but is shown for the purpose of descriptive statistics. Nevertheless, this study gives some voice as to the characteristics of a toilet that would be desirable in rural India.

Study Findings

Demographic Information

Individual Interviews

In total, 40 individual interviews were conducted. These included interviews with community members (n=21), community leaders (n=7), government officials, (n=6) and NGO workers (n=6). Of the 21 community members interviewed, most were farmers (10), manual laborers (6), storeowners (3), masons (1), cattle-owners (1), factory workers (1), or housewives (1). Often, respondents had multiple sources of revenue, such as farming and manual labor, or farming and owning a small store. Of the community members interviewed, 13 were females and 8 were males. In general, questions about caste or tribal affiliation were not asked; however, 6 out of the 10 villages visited were considered scheduled areas, regions defined by the government as containing a significant tribal population and lacking in human development indicators.³⁴ Interviews with community leaders included village sarpanches (elected head of village governing body), ward leaders (elected head of a block subdivision), community resource persons, and secretaries, as well as government officials at

³⁴ Richa Audichiya, Personal Interview, Jan Chetna Sansthan, Abu Road, 17 Nov 2017.

the district, block, and panchayat levels. Finally, NGO interviewees included employees at Jan Chetna Sansthan and the Centre for Microfinance.

Group Interviews

Group interviews were conducted at various events, such as community trainings, self-help group meetings, and government scheme registration sessions, held by Jan Chetna Sansthan. Most of the respondents were women, since Jan Chetna Sansthan focuses on women's empowerment in tribal communities. Though group interviews rarely produced comprehensive responses to all interview questions, they provided greater insight as to the dynamics within a community. When men were present in group interviews, women often remained silent and covered, according to traditional Rajasthani practices. In group interviews of all women, elderly women were allowed the loudest voices in the conversation. Despite these limitations, group interviews typically provided a good launching point for identifying candidates for individual interviews and household observations. A full list of details regarding group interviewees is listed in the Appendix.

Water and Sanitation Practices

People generally obtained water from hand-pumps or wells; piped water was uncommon (Figure 2).^{35,36,37} Water was generally available in central areas, but harder to obtain in hamlets. In some villages, solar purification plants were available, where water could be obtained at a low cost, typically 1 Rs for 5 liters. Additionally, fluoride contamination of water was considered an issue in some areas, such as the Umarni and Sivera villages. In these cases, people would use the hand pumps or wells located nearby their homes for washing clothing or other household tasks but would walk further to obtain clean drinking water. Individuals would also sometimes walk further to obtain

³⁵ Richa Audichya, Individual Interview, Jan Chetna Sansthan.

³⁶ Itika Goyal, Individual Interview, Centre for Microfinance, Sirohi, 21 Nov 2017.

³⁷ Kailash, Individual Interview, Jan Chetna Sansthan, Pindwara, 18 Nov 2017.

better-tasting water. To reach water sources, respondents generally walked an average of 7 minutes, though walking distances ranged anywhere from 1 to 30 minutes (n=17).

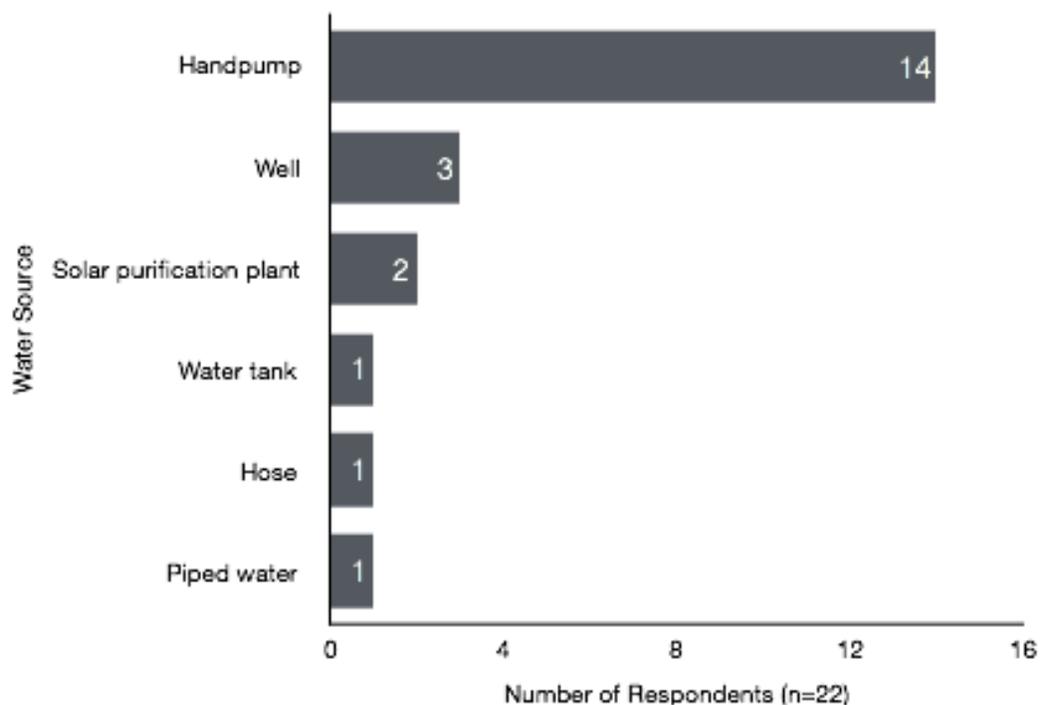


Figure 2: Common sources of water for interview respondents.

Of those who practiced open defecation (n=20), 5 stated that they went near a river or other water source. When asked about whether this would contaminate water sources, Menu Bai, an elderly woman and former community leader of Talwaron Kanaka Village stated that this wasn't a concern, since the villagers did not use the water from the river, but brought their own water from a nearby well.³⁸ Children or infants who were too small to walk to areas for open defecation simply defecated anywhere in the house; family members would later pick up the feces and throw them near the river. For those who quantified the distance that they traveled for open defecation, there was an average of a 13 minute walk, ranging from 1 to 30 minutes (n=9).

³⁸ Community Leader, Individual Interview, Talwaron Kanaka Village, 24 Nov 2017.

Sanitation Beliefs

When asked whether open defecation was good or bad for health, most respondents (6 out of 9) admitted that it was not good for health. Menu Bai of Talwaron Kanaka village stated, “going outside is not good, but the pit [of the toilet] is not deep and there is no water facility so [I] cannot use it.”⁴⁵ Due to the lack of “suitable sanitation facilities,” she perceived open defecation as a necessity.

Toilets were seen as important for women, children, or sick or old people. One of the most common reasons for owning a toilet were privacy (n=6), convenience (n=5), safety (n=2), and health (n=1). Often, respondents would talk about the importance of these reasons as being heavily intertwined. For example, in Ganka Village, privacy for open defecation was becoming an issue due to the rising urban developments in the area. Due to the increased number of new roads in the area, Rani, aged 50, expressed fears of concern for her safety, since there were not many private spaces to use the bathroom and she could be seen by others while defecating outside.³⁹ Similarly, in the Kantal and Siwera Villages, interviewees stated that they chose to build a toilet after marriage because it was unsafe for women and young children to go out to defecate in the forest, especially at night. Seasonal safety concerns were also mentioned, as heavy rains during the monsoon season made open defecation difficult and undesirable.

Toilets were seen as a convenience that could mitigate some of these concerns but were only seen as important for certain groups. The example of Bavaran, aged 59, from Talwaron Kanaka Village, illustrates this phenomenon. Bavaran had one of the five toilets in the village that were built by the government, but didn't use it, because he had a “very good open space for going outside” and didn't want to make it dirty or smelly. However, at the time that we visited, his wife was currently sick and bed-ridden with an unknown infection. He expressed interest in upgrading his toilet to include a larger pit and lighting — though not currently, since money was tight because of his wife's medical

³⁹ Individual Interview 2, Ganka Village, 25 Nov 2017.

bills. If someone was sick or old, he stated that it was good to have an option instead of going outside.⁴⁰

To understand the importance of a toilet compared to other household necessities, respondents (n=13) were asked whether having light, water, a mobile phone, a television, or a toilet was more important. Water (n=6) and light (n=5) were considered the most important concerns over toilets (n=2). However, leisure items like mobile phones and televisions were not considered more useful than toilets. When asked this question, Betti of Chandela Village laughed and said, “If I had a mobile phone, who would I call?”⁴¹

Interviews also revealed other basic priorities that were deemed more important than sanitation. For example, Suresh, a farmer from Dhanga village had one of the few twin-pit latrines observed in this study but did not use it. Since the family needed to walk 20 minutes to the nearest hand pump for water, they found it inconvenient to use their toilet, which required water for flushing. When asked about the importance of a toilet compared to the household necessities listed above, he commented, “money is important, not toilet, because you use money to buy food.”⁴² Similar higher-ranking priorities over sanitation were mentioned in other interviews. As we talked, Menu Bai of Talwaron Kanaka village motioned over to her one-room mud house. If she had enough money, she stated that she would build a better house — not a toilet.⁴³

Toilet Preferences

To understand the type of toilet that households would be willing to use, interviewees were asked about the characteristics of a desirable toilet. A toilet was typically preferred to be located outside the home. Respondents preferred not having the smell of the toilet contaminate spaces inside the house, such as the kitchen. In a group interview with a women’s self-help group, the women

⁴⁰ Individual Interview 3, Talwaron Kanaka Village, 24 Nov 2017.

⁴¹ Individual Interview 2, Chandela Village, 21 Nov 2017.

⁴² Individual Interview, Dhanga Village, 1 Dec 2017.

⁴³ Community Leader, Individual Interview, Talwaron Kanaka Village, 24 Nov 2017.

commented, “A toilet should be outside. [In] cities, [they] put it inside because there is no space.”⁴⁴

However, NGO workers and community leaders commented on the importance of having toilets inside the house due to the patriarchal practices of Rajasthani society. Since traditional practices mandate that women remain covered in the presence of men, it would be difficult for women to use latrines outside of the house since they could be exposing themselves to men and elders, who typically sit outside.^{45,46}

When asked about the features of a desirable toilet, respondents commented that the most important requirement was a water connection. In many villages, toilets were not considered usable due to water scarcity. Toilets were perceived to require between 10 to 15 liters of water for flushing (n=11), and people found it inconvenient and unrealistic to fetch this amount of water for toilets. In Chandela Village, Shabulah Ram stated that it was faster to walk outside with a jug of water and openly defecate, in comparison to walking to the nearest water source, filling up buckets of water, and then using the latrine, especially during emergency bathroom situations.⁴⁷ To eliminate these inconveniences, people expressed a desire for overhead water tanks, which required electricity, or piped water supply in toilets.

Secondly, the next most important characteristic of a toilet was a “large pit.” When asked how deep a pit should be, respondents (n=4) answered anywhere from 6 to 15 feet. According to Rekha of Umarni Village, a toilet with a 10 feet pit was good since it would never fill up and the waste wouldn’t need to be removed. Toilets with small pits were also considered unsuitable for use. In Chandela Village, Betti Bai, a mother of 7 children, had a toilet with a pit that was 3 feet deep. When asked why she didn’t use her toilet, she commented, “How can we use our toilet? We have 9 people living in this house. It will fill up in a month!”⁴⁸

⁴⁴ Group Interview 2, Umarni Village, 19 Nov 2017.

⁴⁵ Richa Audichya, Individual Interview, Jan Chetna Sansthan.

⁴⁶ Community Leader, Individual Interview, Santpur Village, 17 Nov 2017.

⁴⁷ Individual Interview 1, Chandela Village, 21 Nov 2017.

⁴⁸ Individual Interview 2, Chandela Village, 21 Nov 2017.

Other common features of a desirable toilet included adequate lighting and proper ventilation to reduce bad odors and flies. A desired toilet was estimated to cost 31,750 Rs (n=6), and a full listing of all the toilet features described in interviews is shown in Figure 3.

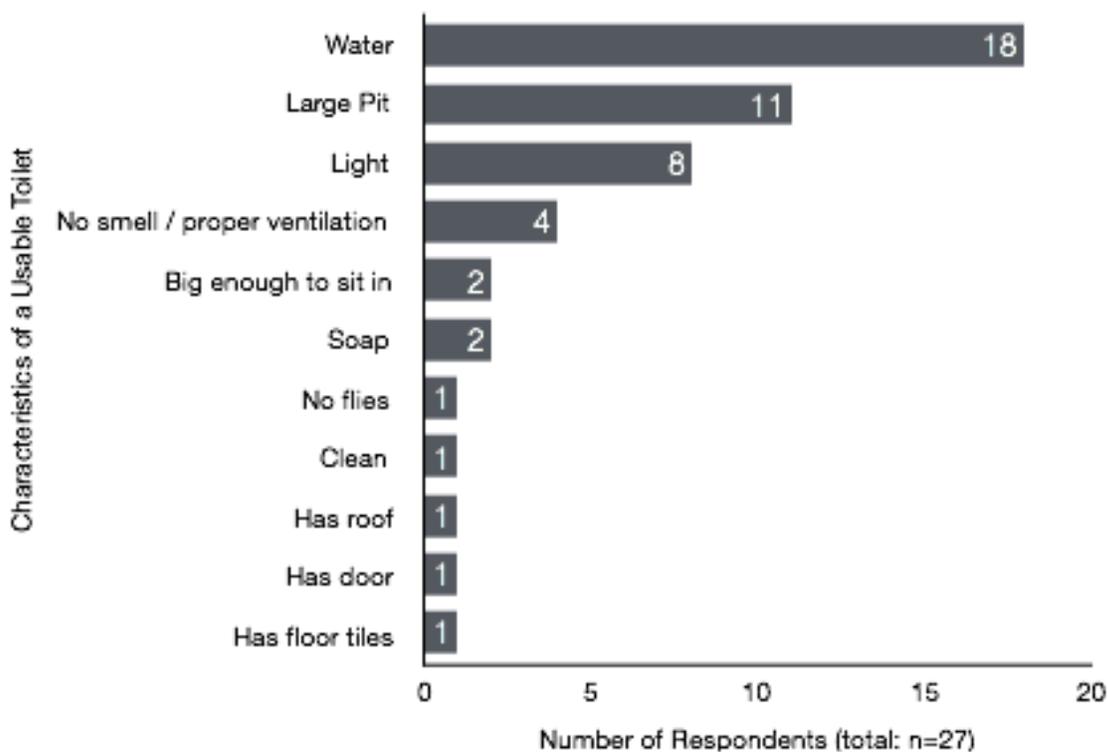


Figure 3: Characteristics of a Usable Toilet. Respondents expressed a need for a toilet that didn't require much water or frequent waste management, along with being overall clean and comfortable to use.

Latrine Observations

To understand what kinds of toilets existed in comparison to villagers' conception of a desirable toilet, 36 latrine observations were conducted. Of the 36 households visited in 10 different villages, most of the inhabitants practiced farming or manual labour as their primary occupation (Figure 4). The exteriors of houses were typically *pakka* (made with permanent materials, such as concrete or brick), with *kaccha* (dirt) floors. Of the 36 latrines observed, nearly half (52%) were constructed by the government, with the remainder being constructed by individual households. It was determined that 56% of the 36 toilets were not being used by seeing whether toilets looked dusty, full

of spider webs, or very dry, triangulating these observations with the owner's responses. However, in nearly all of the cases (94%) in which the toilet was constructed by the household, toilets appeared to be used.

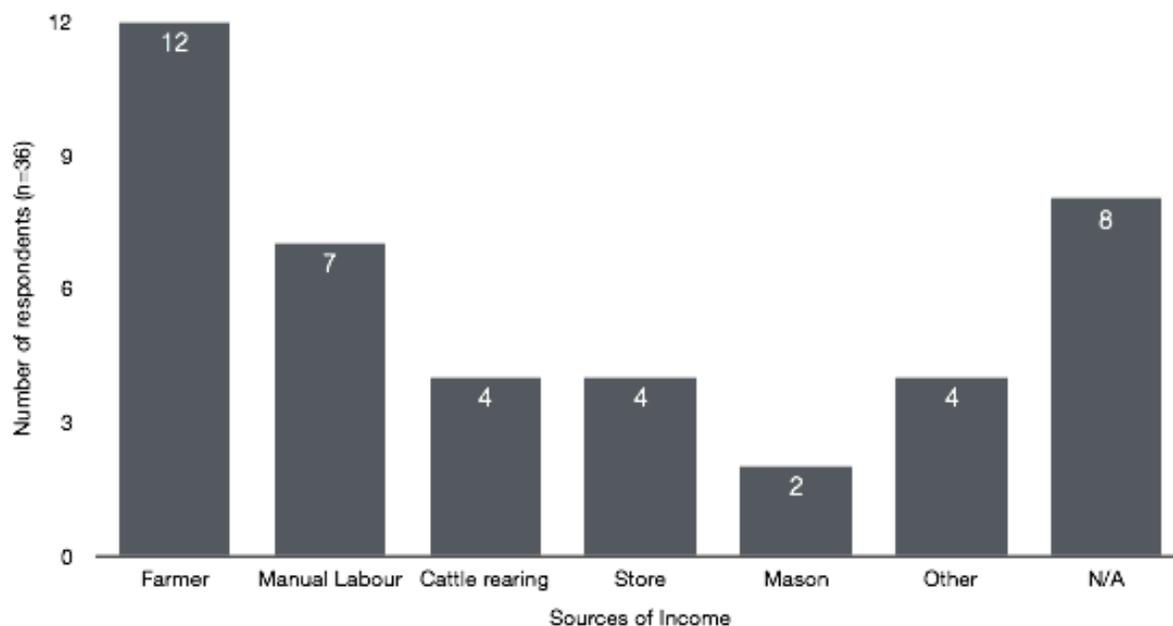


Figure 4: Sources of income for owners of latrines. Other professions included working in schools (2), health centers (1), or serving as community workers (1). Missing responses are listed as N/A (not applicable).



Figure 5: A government-constructed latrine in Umarni Village with a makeshift roof.

Latrines were typically located nearby the house (less than 10m away), with concrete or brick superstructures. Nearly all latrines had roofs (97%), but many of these were makeshift roofs of scrap metal sheeting or non-sturdy concrete slabs, such as the one shown in Figure 5. Few latrines had a piped water source, though 44% of toilets had a water tank attached, as mandated under the guidelines of the Swachh Bharat Mission. However, in several cases, owners removed the water tank attached to the toilet and used it for other household purposes; only 28% of these water tanks were still seen, attached to the toilets. Many owners did not know the size of their latrine pits but of those who did, pit sizes ranged from 3 to 13 feet.

There was often a sizable difference in the quality of toilets constructed by the government and those constructed by individual households. In several cases, government-constructed latrines were broken or unusable. In the three household latrine observations performed in Umarni Village, toilets simply consisted of brick superstructures without pits, such as the one shown in Figure 6. Individual and group interviews confirmed that most of the households in this village possessed these types of “fake toilets.”



Figure 6: A government-constructed latrine in Umarni Village with no pit.

A year ago, government masons had come and built ten of these toilets per day.^{49,50,51} In other cases, government-built latrines were not considered suitable for use. Figure 7 displays the various reasons for non-usage of latrines. In particular, government-built latrines typically had pits that were considered too small for daily usage, or owners found it inconvenient to fetch water for the toilets. Some latrine owners, such as Bavaran, simply preferred going outside to defecate because he had plenty of open space to defecate and didn't want to make his toilet dirty or smelly.

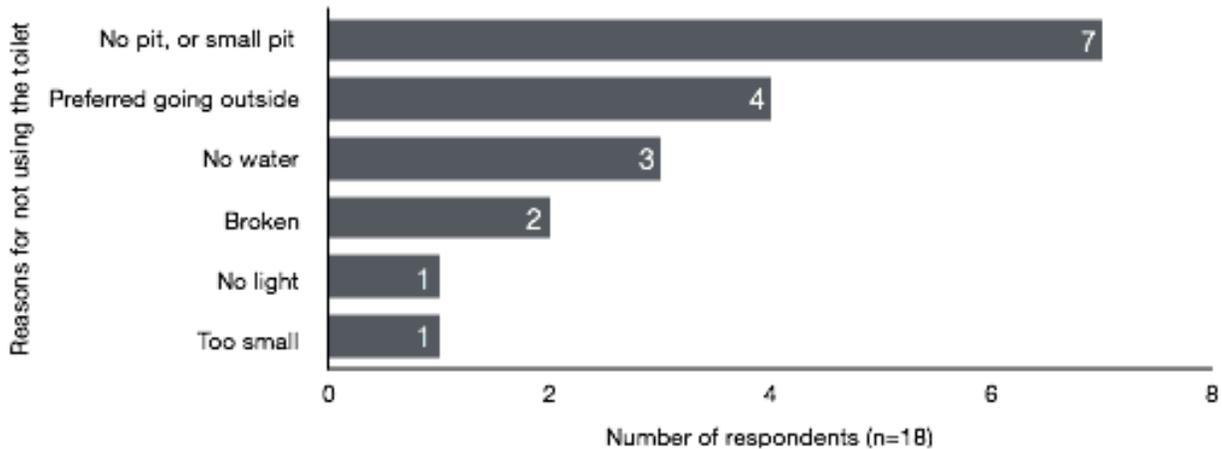


Figure 7: Reasons for not using a household latrine.

⁴⁹ Individual Interview 2, Umarni Village, 19 Nov 2017.

⁵⁰ Individual Interview 3, Umarni Village, 19 Nov 2017.

⁵¹ Group Interview 2, Umarni Village, 19 Nov 2017.

Instead, latrines were often used as storage for firewood or other materials (Figure 8). Some owners also enjoyed using the latrines for showering, as they preferred not to stink up the latrines by urinating and defecating in them. A toilet owner from Talwaron Kanaka Village commented, “[I] don’t like the smell. [I] don’t want to make it dirty. [I] have a very good open space for toilet so it’s better to go outside.”⁵² Owners would often cover the hole of the latrine with a concrete slab and use the latrines for other purposes, as seen in the photo in Figure 9.



Figure 8 (left): Photo of government-built latrine in Umarni Village being used for storage purposes.

Figure 9 (right): Photo of government-built latrine in Talwaron Kanaka Village being used as a shower, with a concrete slab placed over the pit.

⁵² Individual Interview 3, Talwaron Kanaka Village, 24 Nov 2017.

In comparison to government-built latrines, household-built latrines had more deluxe features such as floor tiles, painted walls, and proper ventilation to reduce bad odors. Instead of being located outside the house, several of these toilets were also located inside the house or attached to the house. The average cost of household-built toilets was 44,250 Rs (n=14, ranging from 9,000 to 100,000 Rs). For the purpose of descriptive statistical purposes, differences between government-built and homeowner-built toilets are highlighted in Figure 10; however, statistical significance tests were not performed due to the small sample size and non-randomized sampling.

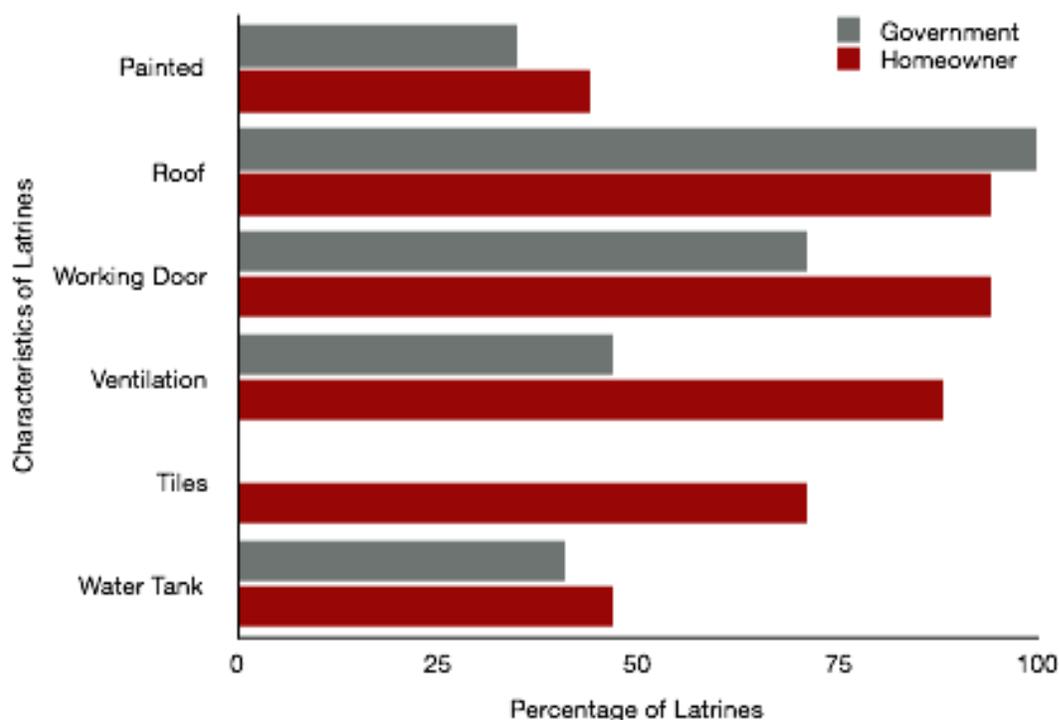


Figure 10: Differences between Government-Constructed and Household-Built Latrines.

Discussion

According to the individuals interviewed in this study, a desirable toilet had a water connection, large pit, lighting, proper ventilation, and other characteristics for comfort like a roof, door, and floor tiles. The estimated average cost of this kind of toilet was 31,750 Rs, nearly three times the amount of the Rs 12,000 (\$185 USD) incentive awarded post-toilet construction. These estimates match the cost of latrines described in Coffey and Spears' study and support the hypothesis that rural Indians have a uniquely expensive concept of a minimally acceptable latrine.⁵³

Large pits were amongst the desirable features of a usable latrine, matching findings in previous studies.⁵⁴ Respondents believed that a toilet should have a pit anywhere from 6 to 15 feet deep and were worried about government-built toilets with pit sizes of 3 feet filling up within a month. This suggests miseducation regarding the length of time it takes for the pits to fill, as it generally takes up to five years for a toilet of 3 feet to fill up for a family of five.⁵⁵ Additionally, few villagers were informed about twin pit toilets, and only two of the 36 latrines observed in this study were twin pit toilets.

The preference for latrines with large pits is potentially harmful, as the depth of large pits can contaminate groundwater sources.⁵⁶ Additionally, the amount of labor required to dig such large pits, especially in rocky areas, adds high costs to toilets.⁵⁷ There thus exists a need for a toilet design which addresses villagers' fear of pits filling up quickly, in conjunction with an education campaign that correctly informs villagers about the length of time it takes pits to fill.

Water is also another area to focus on in terms of designing acceptable toilets. In this study, water connectivity was considered the most important characteristic of a desirable latrine. This makes sense. In this study, the most common reason for owning a toilet was convenience. If toilets are to be

⁵³ Coffey et al., "Revealed Preference for Open Defecation," 48.

⁵⁴ Coffey and Spears, *Where India Goes*, 72.

⁵⁵ "Handbook on Technical Options for On-Site Sanitation," Government of India.

⁵⁶ A Guide to the Development of On-Site Sanitation, *World Health Organization*, 1992.

⁵⁷ Coffey and Spears, *Where India Goes*, 72.

used, they must therefore be convenient for users; toilets that required water to be transported from long distances were not convenient to use. At the same time, villagers displayed miseducation regarding the amount of water that a toilet required. Though a basic pour-flush latrine only requires 1.5 to 2 liters of water per use, respondents believed that a toilet required between 10 to 15 liters of water for flushing.⁵⁸

However, many of the government-built latrines observed through the course of this study did not possess these features and were often considered low-quality and unusable. For example, in Umarni Village, government-built latrines simply consisted of 2 brick walls without a pit. Across all ten villages visited, only 56% of all toilets visited possessed water facilities. Additionally, many toilet superstructures were considered incomplete, lacking roofs and doors. Because these toilets weren't acceptable to their users, they were abandoned or used for other purposes, like storage or showering. 78% of interview respondents reported not using their toilets due to design-related reasons, such as a lack of water connection and adequate size, indicating a need for better-designed toilets.

Partially, the high prevalence of incomplete or malfunctioning toilets shows a reality that is different than the bold goals of the Swachh Bharat Mission. The Swachh Bharat Mission mandates that all household latrines should contain water facilities, hand-washing units, sub-structures, and super-structures acceptable to beneficiaries.⁵⁹ Additionally, the Swachh Bharat Mission has differentiated itself from past sanitation programs by offering individual cash incentives of 12,000 Rs (\$185 USD) to qualifying households after they construct their own toilets rather than providing subsidies. This strategy is based in a demand-driven approach, which focuses on activating communities to develop their own demand for toilets by teaching them about the importance of sanitation.⁶⁰ Yet these guidelines were not followed in many of the villages that I visited, where the government constructed toilets for households rather than requiring them to construct their own toilets

⁵⁸ *Handbook on Technical Options for On-Site Sanitation*, Ministry of Drinking Water and Sanitation.

⁵⁹ *Handbook on Technical Options for On-Site Sanitation*, Ministry of Drinking Water and Sanitation.

⁶⁰ Kamal Kar and Katherine Pasteur, "Subsidy or self-respect? Community led total sanitation. An update on recent developments," IDS Working Paper 257, Nov 2005.

and receive a cash incentive afterwards. However, regardless of whether the government is building toilets for households or providing them with a cash incentive, there needs to be a better mechanism for following up with users and ensuring acceptability of solutions. In these areas, there was virtually no follow-up after these toilets were constructed. Government masons simply showed up one day, built a toilet, and left.

However, local NGOs were working to repair the efforts of the government masons who built these unfinished toilets. At the time in which I visited, the Centre for Microfinance was piloting a new intervention in the Lotana Village of Pindwara Block. Since many of the government- built toilets in the area lacked pits, CMF was outfitting toilet superstructures with Tiger Toilets, vermicomposting tanks containing special worms that break down 90% of waste within 2 hours. These toilets did not require water for flushing and only cost 4,000 INR (\$61 USD), making them an affordable solution. However, usage of these toilets was important, as the worms in the pit would die if the toilet went unused; additionally, the toilets couldn't be installed in rocky areas, which were present in many parts of Sirohi district.⁶¹

This toilet has the potential to address some of the design characteristics highlighted in this study as an odor-free latrine that requires little water and non-frequent waste management. However, simply placing a well-designed toilet into the hands of users will not be enough. Such a program will not be successful without constant user feedback and iteration, in line with the basics of human centered design. Both governments and NGOs can thus gain from incorporating human-centered design strategies into their programs, which simply means taking the time to understand user needs and seek user feedback. Even if the government builds toilets for households rather than providing incentives for self-construction, agency and ownership can still be introduced into the process by including users in the decision-making process of what their toilet should look like. Additionally, continuous monitoring & evaluation efforts to guarantee user satisfaction will ensure that toilets are

⁶¹ Itika Goyal, Individual Interview, Centre for Microfinance.

used post-construction. Thus, governments and NGOs can improve the outcomes of their sanitation programs simply by staying more connected to their users.

Conclusion

This study modeled human-centered design elements to understand strategies for developing more effective sanitation programs. For the villages visited during the course of this study, three main needs were identified: more user-centric toilet designs, campaigns that educate users about the importance of safe sanitation, and better living conditions overall (Figure 11).

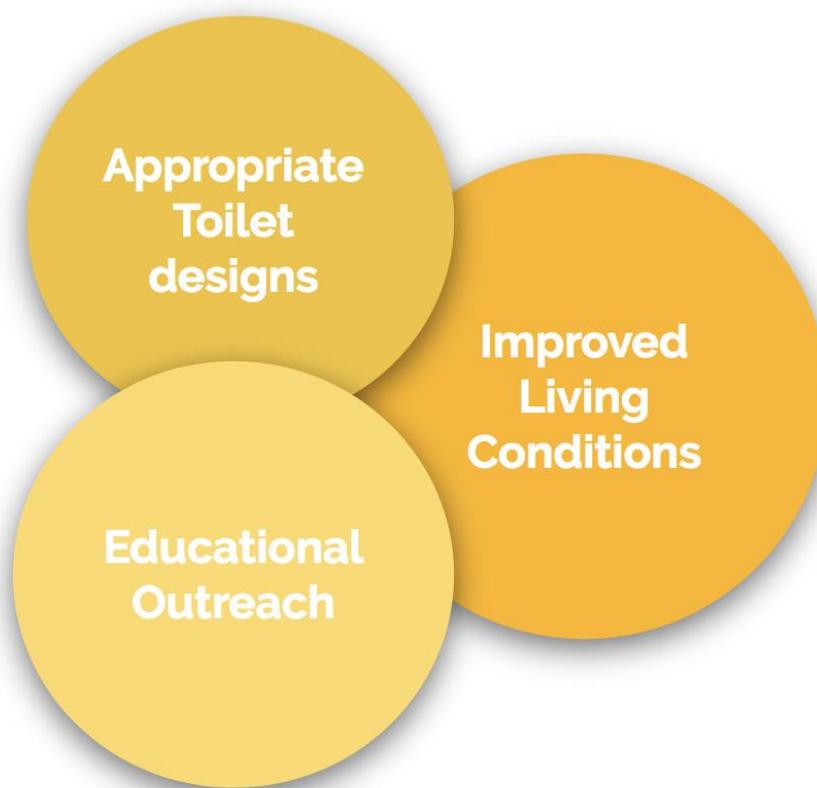


Figure 11: Diagram of Sanitation Needs.

First, there is a need for an affordable toilet design that meets the requirements of its users. Because many of the government-constructed latrines in these villages did not meet household expectations of an acceptable latrine, they went unused. In this study, participants expressed the desire for an odor-free latrine that requires little water, is large enough to comfortably sit in, and does

not fill up quickly. To create effective sanitation solutions, entities must continue to carry out the rest of the steps of human-centered design, prototyping, testing, and seeking feedback from users. For already existing solutions, such as the Tiger Toilet being piloted by the Centre for Microfinance, constant user feedback must be sought to determine whether this is an acceptable design.

At the same time, there is a need for education campaigns that educate users about the importance of safe sanitation. Without proper behavioral change communications, even well-designed toilets might still go unused. Highlighting the need to spread awareness around the importance of safe sanitation, Itika Goyal of the Centre for Microfinance commented, “If someone asked me to use a machine that I have never used — one that I don’t know how to use, why would I use it?”⁶² Some of the misconceptions documented in this study included a lack of understanding around the connection between poor sanitation and health, the amount of time it took for a latrine pit to fill, and the amount of water required to operate a latrine. Along with appropriate toilet designs, there is thus a need for educational awareness campaigns to correct these misunderstandings.

Finally, basic living conditions within villages must be improved. When so many villages visited lacked basic amenities like an accessible water supply and electricity, I wondered whether sanitation should even be a priority for these areas. However, this study has made it clear that a multi-pronged approach is required to raise the quality of living in these areas. Clean water supplies are endangered by unsafe sanitation practices, and safe sanitation practices do not occur without basic necessities like water and electricity. Additionally, as Rajasthan’s population continues expanding, the adverse effects of open defecation becomes more pronounced, as germs from fecal matter are more easily transmitted in highly dense environments.⁶³ Thus, sanitation cannot be neglected in Rajasthan’s quest for poverty reduction, but none of the above-mentioned areas should be forgotten either.

⁶² Itika Goyal, Individual Interview, Centre for Microfinance.

⁶³ Coffey and Spears, *Where India Goes*, 128-155.

Overall, this exploratory study documented the need for more acceptable toilet designs, along with the educational awareness and service provisions needed to accelerate safer sanitation in southern Rajasthan. However, this study most highlights the urgency to listen to the communities that we are trying to serve. At a fundamental level, the individuals that I interviewed in this study did not use their government-built toilets because the toilets did not serve their needs.

Human centered design thus presents an alternative method for ensuring that their programs are meeting the needs of their users. Because human-centered products and programs are designed with users in mind, they incorporate the constraints of their users, such as water scarcity or inconsistent access to electricity, while making sure to address user needs, such as a desire for convenient waste management. Because they are designed in partnership with users, there are multiple opportunities to address misconceptions regarding sanitation. Human centered design thus offers government and NGOs the opportunity to better serve their beneficiaries by understanding user needs and incorporating greater feedback. To learn more about human-centered design, a list of resources is provided in the Appendix.

Acknowledgements

*During the beginning of my semester-long study abroad program in India, I read the book *Where India Goes*, which introduced me to the challenge of sanitation in India. In the book's introduction, the authors write that they wrote the book because they have been humbled by a problem that they do not know how to solve.⁶⁴*

I too have been humbled. Throughout the course of the semester and the compilation of this thesis, I have seen the enormity of this challenge and its immense connections to human health, the environment, and the economy. I am so grateful for having been able to explore a glimpse of it through this research project.

That being said, I have many people to thank for their help in making this effort possible. First of all, I would like to thank the SIT staff: Trilochan Pandey, Murari Goswami, Tara Dhakal, Manoj Sain, and Awadhesh Aadhar for their constant willingness to help. My thesis advisors Dr. Keith Warner, OFM and Dr. Michele Parker also supported me with this work from many many miles away back in the States, and I would like to thank them for their patient support and words of wisdom. I would also like to thank my host organization, Jan Chetna Sansthan and Richa Audichya for their kindness in hosting me and supporting my research endeavors. I am in awe of the steadfast work that JCS is doing. Finally, I would like to thank Itika Goyal and her team at Tata Trust / Centre for Microfinance, Rushabh Hemani and Zahir Abbas of UNICEF Jaipur, and Sanjay Banka of Banka BioLoo for constantly facilitating connections for my research. Without them, this work would not have been made possible.

Finally, I want to acknowledge the many people who were willing to talk to me, an outsider, on their thoughts and beliefs on sanitation. I am humbled to be able to share some of their voices with you.

⁶⁴ Diane Coffey and Dean Spears, *Where India Goes* (India, HarpersCollins: 2017), 22.

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Appendix

Appendix A: Information on Organizations Mentioned in this Paper

Svadha

Svadha is a social enterprise that is based on the principle that local residents are best suited to determine the sanitation needs and desires of their customers. Operating in the Indian state of Orissa, it recruits local entrepreneurs to sell different packages of sanitation solutions, ranging from basic latrines to eco-toilets. Since toilets can break or households may want to upgrade their technologies, the organization also trains its entrepreneurs to perform post-sales follow-up and repairs. This ensures that toilets don't go unused if they get broken, in comparison to government or NGO programs that involve coming to communities, building toilets, and never performing follow-up. Furthermore, this incorporates better processes to allow feedback from users, as entrepreneurs best make a profit by satisfying their customers. Households are therefore able to obtain toilets that meet their own needs and specifications, which drastically improves the likelihood that they remain used over time.^{65, 66}

Banka BioLoo

Founded in 2008, Banka BioLoo is a social enterprise that manufactures and installs bio-toilets in India. These toilets contain special bacteria which digest human waste, producing a gas and water that is safe for gardening, reducing odors and the need for waste management. Through a clause in the Indian law which requires corporations with revenues over 10 billion rupees (\$130M USD) to contribute 2% of their profits to corporate social responsibility (CSR) initiatives, Banka BioLoo partners corporations who hire them to install their bio-toilets in schools as part of CSR initiatives.⁶⁷ Additionally, it has offered a unique value proposition to government entities, such as Indian Railways,

⁶⁵ Ambika Behal, "Meet the Toilet Company That Thinks It Can Fix India's Sanitation Problem," *Forbes*, 24 Nov 2016.

⁶⁶ "About Us," Svadha, accessed 26 February 2011, <http://svadha.com/>.

⁶⁷ Noreen Olrich, "Mandatory Corporate Social Responsibility in India: How is it working?" *Nonprofit Quarterly*, 17 Feb 2017, <https://nonprofitquarterly.org/2017/02/17/mandatory-corporate-social-responsibility-india-working>.

the country's national railway system and 4th largest railway network in the world. Train bathrooms in India are widely unpleasant and deposit their waste across train tracks, requiring employees to manually clean the tracks. Because Banka BioLoo's toilet reduced bathroom odors and eliminated the need of waste clean-up, Indian Railways began purchasing Banka BioLoo's bio-toilets for many of its trains. Partnerships like these with both the private and public sectors have allowed Banka BioLoo to flourish in terms of profitability, allowing it to become the first sanitation enterprise to undergo an initial product offering in India.^{68, 69}

Jan Chetna Sansthan

Jan Chetna Sansthan (JCS) is a tribal, rural, and women's development NGO working in the Sirohi district of Rajasthan. For the past 22 years, they have educated people about their rights and built community-level capacity through village groups in 85 villages, elected women representatives, and self-help groups. Their programs help people to access government programs, such as those offered by the National Rural Employment Guarantee Act (NREGA) and train women to pursue elected leadership roles.³⁴

Centre for Microfinance

The Centre for Microfinance (CMF) is a subsidiary organization of Tata Trust. Since the 1990's, CMF began as a resource organization providing livelihood training to self-help groups, but started focusing on health, education, and water, sanitation, and hygiene (WaSH) to further improve the quality of life in the area. CMF has a three-fold model of increasing access to WaSH tools, employing behavioral change tools, and building local entrepreneurial capacity in the area. In the Abu Road and Pindwara blocks of Sirohi, they have worked on increasing safe drinking water supply,

⁶⁸ Sanjay Banka, Phone Interview, 26 Sep 2017.

⁶⁹ Sanjay Banka, Individual Interview, 12 Nov 2017.

holding sanitation and hygiene awareness programs, and creating sanitation financing for households through loans.

Appendix B: Toilet Design in India

This section details the four main types of toilets in India, as well as which types of toilets are most suitable depending on the environment. There are four main types of toilets in India: (1) dry pit latrines, (2) pour flush latrines, (3) septic tank toilets, and (4) ecotoilets. According to the Government of India, recommendations for the selection of toilet design depend on environmental factors such as water availability and land geography, in addition to personal preferences, such as method of waste disposal and cost.⁷⁰ A dry pit latrine is the simplest sanitation solution, which consists of a squatting platform where waste travels down into a pit. Water is not required for flushing, and the user manually empties the waste once the pit is full. A pour-flush latrine is similar to a dry pit latrine but uses around two liters of water for flushing per use. In non-water scarce settings, this toilet design is optimal since it incorporates a plastic u-bend pan which creates a water seal, preventing bad odor and flies. This design can contain a twin-pit model, where two pits are used alternately. Once one pit fills up, typically in about 3 years, the full pit is blocked at the junction chamber and the second pit is put into use. Inside the pit, the watery component of human waste percolates into the soil through the unique “honeycomb” shape of the pit. By the time that the second pit is full, the waste inside the first pit is semi-solid, free from odor and pathogens, and can be safely removed and used for fertilizing purposes (Figure 1).

Finally, a septic tank toilet diverts waste into a septic tank or water closet, where it is treated through a central sewer system.⁷¹ Generally, 13-19 L of water is used per flush, meaning that households must have good access to a piped water supply to utilize this type of toilet. This type of design is not

⁷⁰ *Handbook on Technical Options for On-Site Sanitation*, Report, Ministry of Drinking Water and Sanitation, Government of India, May 2012.

⁷¹ *Handbook on Technical Options for On-Site Sanitation*, Report, Ministry of Drinking Water and Sanitation, Government of India, May 2012.

recommended for low-resource settings that lack infrastructure for liquid waste treatment, as sludge from a septic tank can pose large environmental and health concerns if treated inadequately. As of 2007, only 232 out of 5000 towns in India were connected to a central sewer system, so this model may not be the most appropriate design for households in many villages.⁷² Lastly, ecotoilets perform the anaerobic biodigestion typically done by septic tanks within each singular toilet unit. Rather than transporting waste to an alternate location for proper treatment, waste processing is performed internally through the help of various bacteria or worms and the resultant product can be sold to farmers as manure.⁷³ Additionally, these designs can be easily implemented in rocky areas, where digging large pits for latrines is difficult.⁷⁴ Generally, septic toilets are the most expensive toilet design, while the prices of ecotoilets can vary depending on the manufacturer and model. Dry pit latrines are the cheapest and most basic sanitation option. Currently, the Indian government's Swachh Bharat Mission is recommending a twin-pit pour flush latrine model due to its affordability and practicality for safe waste removal, and other experts agree with their recommendations.^{75, 76}

Toilet Type	Description	Water Requirement (per use)	Method of Waste Removal
Dry pit latrine	Basic pit latrine	None	Manual
Pour flush latrine	Pit latrine with water seal to prevent odor and flies	2 L	If twin-pit, can be removed by household and used as fertilizer
Septic tank toilet	Traditional flush toilet connected to sewage treatment system	13 – 19 L	Central sewage system
Eco-toilet	Toilet using bio-processes to digest human waste	Depends	Digested by bacteria or worms

Table 1: Main categories of toilets in India.

⁷² Niall Boot, "Types of Toilet and Their Sustainability," Technical Brief, Practical Action, 2008.

⁷³ *Handbook on Technical Options for On-Site Sanitation*, Ministry of Drinking Water and Sanitation.

⁷⁴ *Banka BioLoo - Sustainable Sanitation*, Report, accessed 10 Nov 2017.

⁷⁵ *FAQ on Twin Pit Toilet*, Report, Ministry of Drinking Water and Sanitation, Government of India.

⁷⁶ Coffey and Spears, *Where India Goes*.

Appendix C: Semi-Structured Questions for Individual and Group Interviews

All questions were translated into Hindi through the help of a translator.

Hello, my name is Karen. I am from America. I am a student and I study in Jaipur.

I want to learn about sanitation here. Can I ask you a few questions? I am writing a paper for my studies.

It is completely your choice whether or not to talk with me, and you can choose not to continue our conversation at any time or skip a question. There will not be any rewards for participating or costs for withdrawing. For the purpose of my studies, do you mind if I record our conversation? I will not use the recording for any purposes other than simply remembering the details of our conversation. Do you wish to answer a few questions?

Sanitation Practices:

1. Where do you (or people in this village) use the bathroom?
2. How many minutes does it take you to walk there?^a
3. How many times a day? What time of the day?
2. Where do you get water from?
3. How many minutes does it take you to walk there?^a
4. How many times per day?

Beliefs and Motivators

1. Do you think open defecation is good for health or bad for health?
2. Do you think having a toilet is important? Why or why not?
3. Out of having a mobile phone, refrigerator, TV, or toilet, which is most important?

Toilet Design

1. What are the characteristics of a minimally usable toilet?
4. Should a toilet be located inside the house or outside the house?
5. How many liters of water do you need to flush a toilet per use?
6. How much would such a toilet cost?^b
7. How would you remove waste from such a toilet?
8. Do you know what a twin pit toilet is?
9. Do you know what the Swachh Bharat Mission is?

Appendix D: Interviewer Observation Guide

Below is the structured observation guide that was used when observing household toilets. When possible, questions were asked to toilet owners during this process to understand more about toilet history.

A Demographic Questions	
A.1	What is your name?
A.2	How many people live in this house?
A.3	What is your occupation?

B Household Wealth	
B.1	Interviewer observation: how are the walls of this house mostly like? A) Kachhi (built with earth and organic material) B) Somewhat Kacchi, Somewhat Pakki C) Pakki (built with durable materials like brick, stone, timber, and cement) D) No walls
B.2	Interviewer observation: how is the roof of this house mostly like? A) Kachhi B) Somewhat Kacchi, Somewhat Pakki C) Pakki D) No roof
B.3	Interviewer observation: how is the floor of this house mostly like? A) Kachha B) Somewhat Kaccha Somewhat Pakka C) Pakka
B.4	Interviewer observation: how many pakka rooms does the house have?
B.5	Interviewer observation: how many kaccha rooms does the house have?

C Sanitation Practices	
C.1	Who has toilets in the area?
C.2	Where do you use the bathroom?
C.3	How many minutes does it take you to walk there?

C.4	How many times per day? What time of the day?	
C.5	Where do you get water from?	
C.6	How many minutes does it take you to walk there?	
C.7	How many times per day?	
C.8	Is there a latrine in this house?	

D Latrine History		
D.1	Interviewer observation: Where is the latrine?	A) Inside the house B) Attached to the house C) Near the house (less than ten metres) D) At some distance (more than ten meters)
D.2	Interviewer observation: From seeing the latrine, can you say that the latrine is being used?	A) Yes B) No
D.3	Interviewer observation: What type of toilet is it?	1. crude pit toilet 2. basic pour flush toilet (low cost kaccha) 3. sanitary toilet (pucca toilet) 4. Septic tank toilet
D.4	Interviewer observation: Does the toilet have a super-structure? If yes, approximately how many feet is it? What is it constructed with?	
C.5	How long ago was this latrine constructed?	
C.6	Who made the decision to construct the latrine?	
C.7	How much did it cost to construct the latrine? ^b	
C.8.1	Did you receive any money from the government for the construction of this latrine?	
C.8.2	How much money did the government give for the construction of this latrine?	
C.9	Picture:	

^aAnswers were sometimes given in km or minutes, but answers given in km were converted to minutes by estimating an average walking speed of 5 km/hr.⁷⁷

^bWhen given a range of numbers, the average was taken for statistical purposes.

⁷⁷ Raymond C. Browning, Emily A. Baker, Jessica A. Herron, and Rodger Kram, "Effects of obesity and sex on the energetic cost and preferred speed of walking," *Journal of Applied Physiology* (2006).

Appendix E: Study Site Villages



Label	Village	Gram Panchayat	Block	Date(s) Visited
A	Kkharwala	Kacholi	Pindwara	18/Nov
B	Umarni	Kyariya	Abu Road	19/Nov, 20/Nov
C	Santpur	Satpur	Abu Road	17/Nov
D	Chandela	Chandela	Abu Road	21/Nov
E	Talwaron Kanaka	Ganka	Abu Road	24/Nov
F	Ganka	Ganka	Abu Road	25/Nov
G	Kantal	Ajari	Pindwara	1/Dec
H	Dhanga	Varli	Pindwara	1/Dec
I	Bahadurpura	Bahadur	Abu Road	5/Dec
J	Siwera	Siwera	Pindwara	6/Dec

Appendix F: Information regarding Group Interviewees

Village	Block	Number of people	Description
Umarni	Abu Road	7 women	Meeting for elected women representatives
Kkharwala	Pindwara	5 women	Women's self-help group
Umarni	Abu Road	2 men and 1 woman	Community member discussion
Umarni	Abu Road	7 women	Community member discussion
Umarni	Abu Road	4 women	Training for women to open schools
Santpur	Abu Road	2 men and 1 woman	Meeting with toilet beneficiaries
Chandela	Abu Road	5 women	Community member discussion
Siwera	Pindwara	6 women	Registration for Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA)

Appendix G: Further Resources on Human-Centered Design

IDEO, an international design and consulting firm, has published a free field guide to human centered design which includes detailed exercises for executing the human centered design approach. It can be accessed at: <https://bit.ly/2a0RISK>.

IDEO co-founder, David Kelley, and leading innovation expert, Tom Kelley have also written a book, *Creative Confidence*, which highlights the importance of iteration and creativity in human-centered design.

Acumen, a global venture fund that uses entrepreneurial approaches against poverty, offers a free online course on human-centered design: <https://www.plusacumen.org/courses/introduction-human-centered-design>.