

Willingness-to-Pay for Maintenance and Improvements to Existing Sanitation  
Infrastructure: Assessing Community-Led Total Sanitation in Mopti, Mali

by

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## **Abstract**

In recent years, much focus has been put on the sustainability of water and sanitation development projects. Experts in this field have found that many of the projects of the past have failed to achieve sustainability because of a lack of demand for water and sanitation interventions at a grassroots level. For years projects looked to create this demand through various subsidy schemes, with the “software” of behavior change and education taking a backseat to the “hardware” of infrastructure provision. Community-Led Total Sanitation (CLTS) is a fairly new way of looking at the issues of increasing basic sanitation coverage, promoting good hygiene practices, and facilitating the change in behaviors that is necessary for a level of basic sanitation coverage to be sustained for any significant length of time. CLTS looks to get people to come to the realization that open defecation is dangerous, and that they have to power to stop this practice.

The purpose of this research study was to assess the water, sanitation, and hygiene situation on the ground in villages that through CLTS have achieved open defecation free (ODF) status in the Mopti region of Mali, West Africa. This assessment was done through a willingness-to-pay study, that showed how important sanitation infrastructure was in the daily lives of villagers in this region of Mali. This research study also examines any possible correlations between certain socioeconomic data and willingness-to-pay. A questionnaire was developed and completed with 95 household heads spread across 6 of the 21 ODF villages in the region.

The results of this research study show that the behavior change brought about by CLTS was sustained. Every household in the study had at least one latrine (total latrines = 186), or had access to a neighbor's latrine because theirs had recently collapsed. Of these latrines 82.3% were reported as meeting the Malian nation government requirements of basic sanitation. 89.3% of the observed latrines were built by the participant families themselves using predominately materials that could be found in or harvested from the local environment (e.g., mud, rocks, sticks). Fifty-three percent of the latrines were built completely free of cost, and of the 88 latrines that were paid for in part or in whole the average cost was about US \$13.00. The majority of the participants (64.2%) in the research study reported making improvements and maintaining their latrines, clearly showing the importance of sanitation infrastructure in the 6 study villages. The average cost of this maintenance was about US \$1.50.

Alongside of willingness-to-pay data, more qualitative data were collected on the relative importance of sanitation infrastructure in the daily lives of people in ODF villages in Mopti. This study found that on average throughout the 6 study villages, about 13% of discretionary funds are saved for or spent on maintenance and improvements to sanitation infrastructure on a monthly basis. When sanitation infrastructure investments were compared with other infrastructure and livelihood investments, on the average it was ranked 7<sup>th</sup> out of the possible 10. These data seem to indicate that future investment in sanitation infrastructure was not a high priority for the participants. This could be stem from the fact that many of the participants had not directly experienced the need for continued investments, because their original latrines were still functional.

The willingness-to-pay regression analysis produced very few statistically valid results. Only a few of the correlations found between willingness-to-pay data and socioeconomic characteristics of the sample were found to be statistically valid. For example, the correlation coefficient between willingness-to-pay for pit maintenance, including emptying when full or covering the pit with top soil, digging a new one, and reconstruction, and education level of the participants was about 1.2 and was statistically valid with a t-statistic of about 2.2. Indicating that the more educated a participant was, the more they would be willing to pay for pit maintenance. None of the overall regressions explained enough of the variability in willingness-to-pay data to be considered statistically valid. Regressions for two scenarios, constructing a cement slab as an improvement to an existing latrine and sealing/lining the pit on an existing latrine with cement, explained 10.3% and 10.4% of the variability in willingness-to-pay data respectively. However, this did not meet the minimum criteria of 15%. While the willingness-to-pay data would have been useful to study partners that are piloting a Sanitation Marketing program in Mali, the main research objective of assessing the CLTS intervention was still met.

## **Chapter 1: Introduction**

Lack of access to safe and hygienic sanitation services is one of the biggest problems that people around the world face everyday. In 2008, worldwide only 62% of people were using some sort of improved sanitation facilities, improved sanitation being the means that hygienically separate human excreta from human contact and hence reduces health risks to humans. This figure is much worse in developing countries where only 53% of people had access to improved sanitation. In sub-Saharan Africa, the percentage of the population without access to basic sanitation drops to 31% (WHO/UNICEF, 2010).

Lack of access to sanitation services leads to myriad problems. For example, diseases related to inadequate sanitation kill millions every year, most of those deaths being children under the age of 5 (Montgomery & Elimelech, 2007). It is estimated that water- sanitation- and hygiene-related diseases account for 82,196,000 Disability Adjusted Life Years (DALYs), worldwide (Pruss, et al., 2002).<sup>1</sup> Whether it is a child that misses out on an education because most days they are too sick to go to school, or subsistence farmer who cannot attend their crops, the economic impact of inadequate sanitation is huge as well. A recent study completed by the Water and Sanitation Program (WSP, 2008) of the World Bank concluded that between the four countries of Cambodia, Indonesia, the Philippines, and Vietnam, US\$9 billion per year, or approximately 2% of their combined Gross Domestic Product (GDP), is lost due to inadequate access to

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<sup>1</sup> Disability Adjusted Life Years (DALY) is a measure of disease burden both from deaths and disability. It is expressed as the number of productive years lost due to disability, ill health, or early death.

sanitation (based on 2005 prices). This translates to a per capita loss of US \$22.20.

These losses are mainly due to adverse impacts on health and water resources, the health cost being primarily due to premature mortality and the water-related costs being primarily from costs associated with access to clean drinking water (e.g., time lost fetching water, costs of treatment, costs of purchasing bottled water) (Hutton, et al., 2007).

The United Nations (UN) recognized the issue of inadequate access to sanitation in 2002 when it was included in the targets of Goal 7 of the Millennium Development Goals (MDGs). Goal 7 Target 10 was modified to state the goal of halving, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. It has also been shown, notably by Lenton, et al. (2005), that meeting this one MDG will greatly impact the progress towards all the MDGs. Table 1.1 shows the impact of improved access to safe drinking water and basic sanitation on each of the MDGs.

For years the development and aid community has been working to increase access to sanitation services around the world. Traditionally the focus has been on providing families with sanitation technology in the form of a free or subsidized latrine or toilet. For many years, however, people working in the sanitation development field have realized that simply providing technology and infrastructure is not enough. The demand for the infrastructure and the willingness of individuals to change some of their most intimate behaviors must be present in order to make sanitation development projects successful and sustainable.

Through the 1990s, a gradual change began throughout the sanitation development community, moving from technology and supply driven models to

**Table 1.1:** Contribution to each of the Millennium Development Goals of improved access to drinking water and sanitation.

Millennium Development Goal	Contributions of improved access to safe drinking water and basic sanitation
To halve the proportion of the world's people whose income is less than \$1/day	<ul style="list-style-type: none"> <li>• Much of poor families income must go to the treatment of diseases related to lack of access to safe drinking water and sanitation infrastructure.</li> <li>• The time it takes to collect water and open defecate could be put to more productive use.</li> </ul>
To halve the proportion of the world's people who suffer from hunger	<ul style="list-style-type: none"> <li>• Parasitic worms steal calories and nutrients from hosts, these worms are associated with poor drinking water and sanitation access.</li> </ul>
To ensure that children everywhere complete a full course of primary schooling	<ul style="list-style-type: none"> <li>• Water and sanitation related diseases keep kids, especially girls, out of school.</li> <li>• Time spent fetching water and open defecating takes away from time in school, again especially for girls.</li> </ul>
To ensure that girls and boys have equal access to primary and secondary education	<ul style="list-style-type: none"> <li>• Women are often involved in water and sanitation related community-based organizations, which in turn encourages everyone to have women play a bigger role in the community in general.</li> </ul>
To reduce by two-thirds the death rate for children under the age of five	<ul style="list-style-type: none"> <li>• Diarrheal diseases, caused mainly by lack of access to clean water and adequate sanitation, are the second leading cause of postneonatal childhood mortality in the world (WHO, 2004)</li> <li>• Childhood malnutrition, including sub-optimal breastfeeding, cause an estimated 35% of worldwide child deaths (WHO, 2004). These conditions are often caused by water-related diseases such as intestinal worms.</li> </ul>
To reduce by three-fourths the rate of maternal mortality	<ul style="list-style-type: none"> <li>• Health-care facilities without access to safe drinking water and sanitation are not able to provide a hygienic environment for birthing.</li> <li>• Access to safe drinking water and sanitation during pregnancy reduce the incidence of anemia, which in turn brings down maternal mortality.</li> </ul>
To have halted and begun to reverse the spread of HIV, malaria, and other major diseases	<ul style="list-style-type: none"> <li>• Diarrhea morbidity is reduced by 21% with improved water supply, 37.5% with improved sanitation, 35% with hand washing, and 45% with including point-of-use disinfection in drinking water supply schemes.</li> <li>• Water-borne, -related, and -washed diseases account for 1.6 million deaths per year.</li> </ul>
To stop the unsustainable exploitation of natural resources; to halve the proportion of people without water and sanitation; to improve the lives of 100 million slum dwellers	<ul style="list-style-type: none"> <li>• Basic sanitation provides for reduced nutrient loads to sensitive ecosystems.</li> <li>• Slums are, by definition, areas where there is inadequate access to improved water and sanitation infrastructure.</li> </ul>

*Adapted from: Lenton, et al., 2005 unless otherwise cited.*

educational and demand driven models for increasing the coverage of improved sanitation. Cairncross (1992) said that the principal lesson learned from the International Drinking Water Supply and Sanitation Decade (1981 – 1990) was that:

*Progress and continuing success depend most on responding to consumer demand...where sufficient demand exists, the facilities and services offered must be tailored to that demand; where demand is not strong, it must be stimulated.*

LaFond (1995) took this a step further, saying that not only should projects focus on bringing demand into the picture, but also involve the community in projects at an early stage, as well as, focus on changing sanitation and hygiene behaviors and building the capacity of the community to continue the project into the future. In 1997, the United Nations Children's Fund (UNICEF) set out guidelines for its employees and partners to view themselves less as “providers” and more as “catalysts.” They shed light on the fact that hardware components of sanitation had received most of the budget allocations, and the “software” components (hygiene education, community participation, training, etc.) were underfunded and often completely forgotten (UNICEF, 1997). This gradual shift in focus and ideas continued through the late 1990s in the sanitation development community (Wright, 1997; DFID, 1998; WSSCC, 1998; Fang, 1999; Kalbermatten, et al., 1999) all the time growing towards more community-driven projects and processes.

One of these processes that emerged in the late 1990s and early 2000s is known as Community-Led Total Sanitation (CLTS). It was developed by Dr. Kamal Kar in Bangladesh, and has since spread throughout much of the developing world. From Asia to Africa to Latin America, people are working, through CLTS methods, to help others to understand the dangers of open defecation and utilizing existing social structures and pressures to help communities become open-defecation free (ODF). The CLTS

methodology is simple: break the silence taboos around open defecation. Get people talking about open defecation, and the dangers, filthiness, and unhealthiness of it will become apparent and people will want to do something about it. This process empowers communities to take action against open defecation and often shows extremely fast, positive strides in the direction of complete sanitation coverage and the health, economic, environmental, and social advantages of communities being ODF.

With only an estimated 36% of the population having access to improved sanitation (WHO/UNICEF, 2010) and 22,600 deaths/year attributable to diarrheal disease (WHO, 2009), Mali, West Africa is one of the countries most in need of increased access to sanitation. CLTS was introduced to Mali in March 2009, when Dr. Kar held a regional workshop, attended by representatives of 10 francophone countries in the region, in Bamako, Mali. Since that date, over 260 communities have been “triggered” and so far 65% of these communities have reached ODF status (UNICEF – WCARO, 2011). This project has resulted in more than 250,000 people gaining access to safe, clean sanitation infrastructure and positively changing hygiene behaviors (UNICEF – WCARO, 2011). While the introduction and initial scaling-up of the CLTS program in Mali has been successful, much work still needs to be done in order to reach the MDG for sanitation as well as progress towards the ultimate goal of improved sanitation for all.

In order to reach these high goals, much effort must be made to make all sanitation projects sustainable. Through monitoring and evaluation of the program and letting the process evolve as the specific situation changes throughout Mali, we can grow a truly sustainable intervention that will make great strides in the sanitation sector. It is in this spirit of always evaluating and improving programs that this study was done. This

research study specifically looks at the situation on the ground in ODF villages in the Mopti region of Mali. The author of this thesis assessed the socioeconomic status of the villages, the sanitation and hygiene behaviors brought about by CLTS and sustained by the community, and the importance of sanitation infrastructure in the everyday lives of the people in these villages. These data and associated assessment should help to accurately depict the sanitation situation in ODF villages and make suggestions on how to improve the implementation of CLTS throughout Mali and the world.

### 1.1: Objectives

The main objective of this thesis was to assess the importance of sanitation infrastructure in the daily lives of people in ODF villages in Mopti. The study has the following hypotheses, that CLTS produces sustained behavior change, increases demand for sanitation infrastructure, and thus is one of the most effective and efficient means to increase access to basic sanitation around the world. Furthermore, a goal of this research is to find any possible correlations between certain socioeconomic data and willingness-to-pay, and to make these correlations and willingness-to-pay data available to research partners who are piloting a Sanitation Marketing campaign in this region of Mali.

Important to this effort was to learn exactly how important sanitation infrastructure is in people's daily lives. Knowing this information one should be able not only to assess the effectiveness of the CLTS intervention in Mopti, but also have a set of economic data that can be used in piloting a Sanitation Marketing campaign alongside CLTS throughout Mopti and Mali. Sanitation Marketing brings together local artisans, masons, entrepreneurs, and development partners to make sanitation hardware a market commodity, setting up sound businesses that will sustain the promotion of improved

sanitation (Cairncross, 2004; Rosenboom, et al., 2011). Combining CLTS and Sanitation Marketing can provide a powerful “one-two punch” to reducing the population without adequate access to improved sanitation long into the future. CLTS can provide the initial demand for sanitation hardware, and Sanitation Marketing can help communities to meet this demand and continue promotion through marketing campaigns (Cairncross, 2004; WSP, 2008; Sijbesma, et al., 2010; Rosenboom, et al., 2011). The data provided by this study will be invaluable to entrepreneurs and partners working on a Sanitation Marketing program in Mopti region and throughout Mali.

## **Chapter 2: Literature Review**

As discussed in Chapter 1, Community-led Total Sanitation (CLTS) is the brain-child of Dr. Kamal Kar. In the late 1990s, Dr. Kar came to the conclusion that the Bangladeshi government program of subsidizing the construction of latrines was failing to generate demand for sanitation and that a new approach was needed. He developed a new methodology while working with a local nongovernmental organization (NGO), Village Education Resource Centre (VERC) and international nongovernmental organization (INGO), WaterAid. Together they were able to facilitate real change in the first communities. The villagers themselves became campaigners for sanitation and eventually a shameful view of open defecation was embedded in the hearts and minds of the general population. Then something amazing happened, without any subsidies whatsoever, the villagers began to build hygienic latrines through various innovative methods and using local materials (Ahmed, 2009).

Since then CLTS has spread to many areas of Asia (including now Bangladesh, India, Pakistan, Indonesia, and Nepal) and elsewhere around the world. For example, CLTS has spread to over 40 countries in Africa, Latin America, the Pacific, Asia, and the Middle East. It was introduced into Africa in 2002, but did not really start to gain any ground until 2007, when Dr. Kar held two trainings of facilitators in Tanzania and Ethiopia. After those trainings CLTS has spread quickly throughout the sub-continent, with Dr. Kar traveling to other sub-Saharan African countries, including Mali, Kenya,

Ethiopia, Uganda, Nigeria, and Ghana. It has now been introduced in 32 African countries (Bongartz, et al. 2010).

## 2.1: What is Community-Led Total Sanitation Exactly?<sup>2</sup>

The idea of CLTS is pretty simple, how do we get people to realize that if they are defecating in the open they are most likely eating, and drinking, their own and their neighbor's excrement? This is facilitated through many interactive activities done during only a few hours, no more than one day, in the villages. There is no set agenda or methodology for doing this. CLTS facilitators must be charismatic and adaptive to the specific situation in particular villages. Dr. Kar says that the best facilitators will be able to sing and dance, although that is not necessarily what the facilitator will be doing, they just need to have that kind of interactive and creative personality.

**Table 2.1:** Community-Led Total Sanitation step-by-step

Triggering	Bringing people to the realization that if they are practicing open defecation they are simply eating and drinking each others' excrement.
Igniting	Helping people to say, “open defecation is a problem, and we as a community are going to do something about it.”
Action Planning	Planning for and making a commitment to end open defecation.
Post-Triggering	Following up on the community's commitment, verifying and certifying open defecation free status.
Scaling Up	Taking the show on the road, using the natural leaders that emerged from the first ODF communities and turning them into facilitators to trigger more villages. Bringing Sanitation Marketing into the picture.

### 2.1.1: Triggering

The CLTS handbook (Kar & Chambers, 2008) offers some example activities that have worked in the past. These activities often start with a transect walk or “shit<sup>3</sup> walk”.

This is the first introduction of the villagers and the outside facilitators to the primary

<sup>2</sup> Information in this section comes mainly from the CLTS handbook (Kar & Chambers, 2008) and the CLTS trainers handbook (Kar, 2010), other references are as noted.

<sup>3</sup> It is very important to the process that the literal translation of the word shit is used throughout. This reinforces the point that shit is dirty, disgusting, and dangerous, and can help break silence taboos.

effect of open defecation (i.e. the shit actually on the ground). During the transect walk, the facilitators ask to be shown the places where people are defecating in the open. They spend as much time as possible in these areas, to maximize the feeling of disgust and shame at an outsider being shown their most private, and often unspoken of, area of their village. While in the places of open defecation, the facilitator starts to ask leading questions, always only asking questions never teaching, never preaching, never promoting anything. These questions could be as follows, do flies like dry shit or wet shit? What does it mean when the shit is wet? When it rains where does this shit go? Are these flies that you see around here different from the flies that are around your house and that land on your food?

The transect walk is a very powerful tool for promoting disgust at open defecation and icebreaker for the community. The villagers that see strangers out walking through their areas of open defecation will become interested and follow. The facilitators then direct the community to a large open gathering place, like the school or the village square, and they continue the discussion about open defecation. During this part, usually there is a large group of people around and this group can be split up into groups of children and adults (in some cultures it will be necessary to separate women and men as well). With these groups the facilitators usually commence with making a community map.

These maps are an interactive way to show people all the places that they go to open defecate. These maps are often drawn on the ground or on a chalk board in a school, all that is needed is some material (e.g., chalk, rice husks, sand) to mark out the areas of open defecation and important village landmarks. First villagers will be asked to

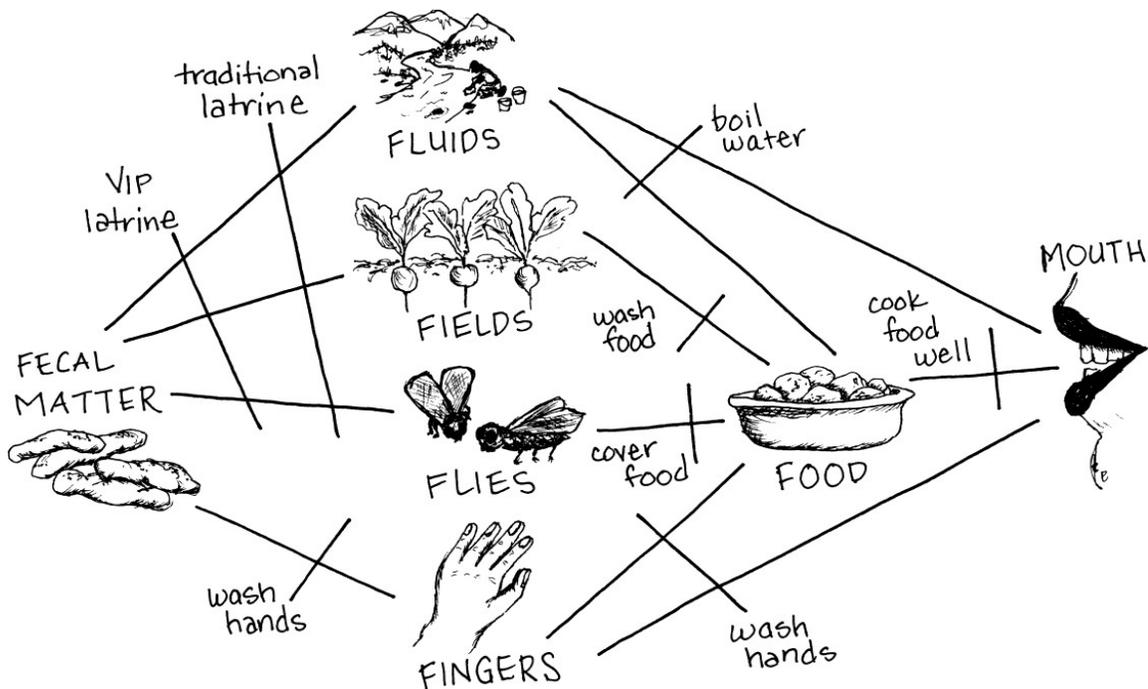
mark their houses and the main areas where their family goes to open defecate, then they mark the places that they go to defecate in emergencies or when they are sick. Eventually the people realize that not only are their neighbors often using their backyard for open defecation, but nearly all the village is covered in feces. The facilitators then ask the people which is the dirtiest neighborhood and more demographic information, mainly where all the poor families live and which neighborhoods have the most people and most space. Usually people will start to see that the dirtiest and grossest neighborhoods are often also the poorest. Villagers will also begin to see other patterns, all adding up to the fact that they, as a community, need to work to stop the dangerous practice of open defecation.

The next steps can be combined with the community mapping, both finding out that the community is covered in feces and seeing contamination through “shit and food” and “shit and water” at that same time can be a powerful catalyst for behavior change. The facilitators will collect fresh excrement from the places of open defecation and bring it with them to the big group meeting. They will bring out a plate of food and ask the people if they would eat it, most of the people will say yes. The facilitators then set the plate down next to the fresh excrement and continue talking about something else. The villagers will be able to actually watch the flies that are almost immediately drawn to the fresh excrement and food go from one to the other, and later when the facilitators ask if anyone would like to eat the food, everyone will flatly deny it.

“Shit and water” involves the facilitators plucking a hair from their head and dipping it in the fresh excrement. They will then dip the dirty hair into a bottle or cup of water and offer it to the people. They will talk about not being able to see any shit in the

water, but everyone knows that it is there because they saw it put in there. The facilitators will then ask how many legs flies have and if their legs are hairy or not and ask if they carry shit away with them after they land on it.

Other activities that the facilitators can use are the “calculation of shit”, where villagers will calculate how much excrement they produce in a day, week, month, and year leading to a disgustingly huge amount of shit being left in the open. The “calculation of shit costs” is an activity where villagers figure out how much they spend on treatment of diarrheal diseases per month or year. It often helps to have the community to make their own version of the “F-diagram”, detailing all the ways that shit in the open can get to their mouths (See Figure 2.1 for example).



source: Mihelcic et al., 2009, used with permission

**Figure 2.1:** The “F-Diagram” of fecal-oral transmission routes.

### 2.1.2: Igniting

This is a very powerful, visual, and interactive process, and at some point in the process the villagers will come to the realization and exclaim, “we are eating our own

shit!” Once this is stated in public, the facilitators will repeat and reinforce that idea while continuing the process. It is this idea that must be embedded into the hearts and minds of the people of the village. The shame and disgust will build up to critical levels and then will break loose at the “ignition point”, where the villagers say, “we are eating our own shit, and we are going to do something about it.” At this point, while still not selling the idea of building latrines, the facilitators will turn the discussion to what the village is willing to do about this problem. Often people will complain that they want to do something, but they do not have the money to build latrines. The facilitators then explain that other people around the world have used local materials to build latrines quite inexpensively, sometimes as low as US\$ 3 – 4. They will then share with the people some simple latrine designs and ask a few of the people to share some of their ideas for how to build latrine. At this point the facilitators will ask for the community's commitment to build latrines and a date when they can return to see how things are going.

Obviously, just as this process has to change based on the differences from village to village, the response to this process will be different in each village. The CLTS handbook puts possible community responses into four different categories from the most promising “matchbox in a gas station”, where the entire community is ready to immediately set into action a plan to stop open defecation, to the least promising “damp matchbox”, where the entire community is not at all interested in taking their own action to stop open defecation.

Where the response is a “matchbox in a gas station” the facilitators can continue talking about the details of how the community is going to achieve ODF status. A discussion of where to take this response can be found in Section 2.1.3.

The facilitators may also proceed with action planning when the response is “promising flames”, where the majority of the community has agreed to stop open defecation but not all have decided. However, in this case the facilitators should work hard to encourage and support the “natural leaders” in the community that are the first ones to agree to stop open defecation and start constructing sanitation facilities. These individuals should be brought out of the crowd and applauded for being willing to help their community to become clean and healthy. These first adopters will then be asked to help the facilitators to continue with action planning.

The third possible response is called “scattered sparks” and is characterized by the majority of the villagers being undecided and only a few thinking about moving forward towards ODF status. In this case, the few natural leaders that do emerge become all the more important and must be supported and helped in every way. The facilitators will also ask more leading questions and otherwise draw out the collective disgust and shame of open defecation. They will ask people to raise their hands if they will defecate in the open tomorrow, and tell the villagers they are leaving the area knowing that the people there want to continue eating each others' shit. If at this point a few natural leaders do emerge and want to talk about where to go from here, the facilitators can continue with action planning with them. The facilitators will also set an early date (within two weeks or so) to return to the village for further “ignition point” activities, mainly bringing out and supporting natural leaders, soliciting commitments, and action planning.

The fourth, and least promising response, is called “damp matchbox”, where the community is not at all interested in stopping open defecation. In this case, the facilitators should thank the community and leave, stating that it is very surprising that they know they are eating each others' shit and yet want to continue doing it. With “damp matchbox” as well as “scattered sparks” it is often a good idea to ask the villagers if they would like to go to visit a village that has been declared ODF through the community working together. This can be a powerful motivating factor, even if the villagers do not end up traveling, just knowing that a village near them has achieved ODF status.

In all of the above responses the communities should be left with some method for testing their drinking water. This usually can be done in the form of simple hydrogen sulfide testing vials available in markets, from chemists or drugstores, or at water testing facilities. These vials are a simple way for the villagers themselves to test some of their drinking water sources and see that open defecation leads to shit in their drinking water.

### 2.1.3: Action Planning

If the community response is such that will allow it, the facilitators should continue with community action planning. On this first day, when the village has just been triggered, this process can be very simple, mainly just getting a basic commitment from the community and their plan to eliminate open defecation. The people that are willing to immediately start taking action against open defecation, should be asked to sign their names to a list and raucously applauded. These first adopters can be asked if they are willing to donate to other families without means in the community, and applauded for promised donations as well. The facilitators will ask when they can expect the village to reach ODF status, and will encourage the village to make that as little time

as possible (“Is 60 – 90 days of eating each others' shit really acceptable?”). The facilitators will also work with an existing or form a sanitation committee in the community that will be responsible for keeping track of the community's progress towards ODF status, making connections with local sanitation hardware suppliers, and helping with both the technical (construction and design of latrines) and financial (distribution of donations or setting up a micro-savings/financing group) aspects of reaching ODF status. The facilitators will also help the community to produce a large paper map of the village in which all the homes, important places (mosques, churches, schools, and other social gathering areas), and open defecation areas are clearly marked. This map needs to be large enough to allow space for keeping track of which houses have installed latrines and which areas of open defecation have been eliminated. The sanitation committee will be responsible for displaying this map and updating it as the community nears ODF status.

Throughout the entire process there is no mention of monetary support or subsidy. There is also no mention of being there to promote latrines or latrine use, the facilitators are there to learn about the sanitation situation in the village and that is it. It is vital to this process that the ideas and motivation come from within the village. Experts say that this process will not work if the community members have any motivation other than truly wanting to stop the dangerous practice of open defecation, and this means that no subsidy should be given or even discussed with the community. This important aspect of CLTS will be discussed in more detail later.

#### 2.1.4: Post-Triggering

After the first day of triggering much must still be done to encourage and support the community on their way to achieving ODF status. Before leaving the village on the day of triggering, an early date should be set when the facilitators can return and check on the progress. Focus should be placed on the villages with the best responses. For a “matchbox in a gas station” and “promising flames” responses, return after only a few days. For a “scattered sparks” response, return after about a week or two. For a “damp matchbox” response, return is not suggested unless some people want to know more, in which case a visit to a neighboring ODF village could produce positive results. Facilitators should always give specific reasons for their return, “We’re coming back to see the results of the water tests,” or, “We’re coming back to see the first latrine completed.” It is important to include local government officials and village leaders in follow up visits, as the pride of the people showing off their latrines will be greatly increased by this.

On follow-up visits effort should be made to meet with the sanitation committees formed on the day of triggering. Facilitators will need to see if they can help the committees in anyway to identify and form connections with local sanitation hardware providers, help with any technical questions they might have, as well as simply continuing to motivate and encourage the committees to continue their good work. Encouragement can also be offered to the sanitation committees and natural leaders in the communities by calling their cell phones or otherwise distance communicating, if available.

Effort should also be placed on encouraging more economically affluent families to help less affluent ones. Donations should be sensitively solicited, and the people that make donations should be called out in front of meetings and applauded. This has often led towards more people stepping forward with donations of their own, seeing the honor given donors.

Throughout all follow-up visits, the facilitators should keep an eye out for both positive and negative developments in the community. Some positive signs to look and encourage for include: innovation in latrine design and use of local material; wealthier people from the community donating hardware, labor, land, or money to poorer people; natural leaders emerging; people with completed latrines wishing to talk to others; and local leaders calling meetings or otherwise talking about reaching ODF status and the dangers of defecating in the open. Some negative signs to look out for and immediately try to mitigate are: people saying that subsidy may be forth coming; other organizations that offer subsidies intervening and subverting CLTS; doubts being raised on technical grounds. There are many ways to mitigate some of these issues, for example, if people in the community seem to be waiting for subsidies the facilitator could ask how long they are willing to wait while continuing to eat each others' shit or if subsidized latrine programs have worked in the past. Visits with other villages or areas that are in the process of becoming ODF or have reached that goal can help as well. This gives people opportunity to share ideas and troubleshoot common problems that may have arisen.

Throughout the CLTS process effort should be made to include all interested parties. This is especially important in the post-triggering phase, when the added influence of an important person or newly emerged natural leader can provide the final

push towards ODF status. Facilitators and community leaders should look for and encourage newly emerging natural leaders, be they women, children, religious leaders, local government officials, village elders, or youth groups. Children have often been a powerful tool in CLTS. They can be taught to chant slogans or sing songs against open defecation, can be given whistles and told to identify and call out people defecating in the open, or even be used to assert social pressure on their parents to build a latrine. Children are often found to be among the fastest adopting and most passionate promoters of the social change that is necessary to bring about ODF communities. Religion has also proven to play a significant role in the success of CLTS. Religious leaders are often the most effective agents of social change, and religious reasoning can often be exploited to spur this change. For example, people realize quickly that the cleanliness of clothes that is required of Muslims for prayer is not possible when there are so many flies landing on clothes and smearing them with feces.

This participatory and community-driven approach to sanitation also needs participatory and community-driven monitoring and evaluation. It should be the natural leaders and the sanitation committees themselves who monitor the community's progress towards ODF status. Communities should be allowed to specify their own set of indicators and monitor these indicators in their own way. For example, one of the indicators of success may be a reduction in the amount of flies, and the community can test this by cutting up mangoes or other pungent fruit in an open area and noting the amount of flies that are attracted to it.

Once the village thinks that ODF status has been achieved some kind of independent verification and certification process must be observed. The criteria and

process for verification and certification should be community-driven as well. For example, a group of natural leaders write up a set of criteria for ODF status, and invites local government officials to come to the village and complete the criteria write up, the government officials afterward declaring the village ODF. Pride should be taken in reaching ODF status, and communities that do should celebrate, put up signs declaring their village ODF, and making an effort to make this known to other villages in the area that have not yet been declared ODF.

#### 2.1.5: Scaling Up

The scale up and dissemination of information always must be considered if an intervention is going to become wide-spread and have any real effect on the problems the intervention is trying to address. CLTS has faced many issues while going through the process of scaling-up. At times the speed of spread has been a hindrance to the overall integrity of the process, as the quality of training of facilitators, of triggering, and of pre- and post-triggering activities has not met the standard that is necessary to facilitate real change in communities. The CLTS handbook (Kar & Chambers, 2008) says that the training of facilitators must be of the highest quality and always a direct hands-on approach that includes CLTS triggering in villages. This has been achieved through working with organizations that are committed to CLTS, creating networks of people trained in and devoted to CLTS, mounting training and triggering campaigns, and turning natural leaders from ODF villages into CLTS facilitators in other villages.

Organizations that wish to take CLTS to scale must be committed and understand that CLTS is very different than many traditional approaches to sanitation development work (Chambers, 2009). These organizations must often change success indicators, for

example from counting latrines installed to counting communities reaching ODF status. Since an organization working in CLTS must not be providing subsidies for communities to build latrines they often will need to change the way they budget sanitation programs. With CLTS the spending starts out slowly and builds as more trainings of facilitators, visits to ODF villages, and capacity building activities require funding.

CLTS campaigns have proven to be a good way to take CLTS to scale across a region. A campaign over a region or a country can help to foster the competition between communities, districts, regions, or states that increases the social pressures to each community being declared ODF. Campaigns have been most successful when a few key factors are included: wide-spread support throughout the government structure, full-time devoted campaign staff, strict verification of ODF status, celebration of reaching ODF status, and the use of media be it television, radio, newspapers, or theater. Campaigns have been successful in taking CLTS to scale in large areas of the countries of Bangladesh, India, and Indonesia. For examples of taking CLTS to scale through campaigns and other programs see, Priyono (2008). Deak (2008), Chambers (2009), Hickling & Bevan (2010), Soubliere (2010), Zulu, et al. (2010).

Another major issues that must be considered when looking to scale up a CLTS program is the availability of sanitation hardware. As CLTS spreads and more communities near or reach ODF status, the demand for sanitation hardware will grow. Organizations need to build capacity of local hardware retailers and manufacturers, by training interested parties on the manufacture and installation of sanitation hardware, helping to identify and encourage ways for retailers to buy in bulk, and encourage Sanitation Marketing. Sanitation Marketing is a key component of CLTS projects in

India, Indonesia, and Tanzania. These projects help local entrepreneurs develop as well as strengthen linkages with external entrepreneurs. These projects look to build capacity of entrepreneurs to get them to treat the provision of sanitation hardware as any other business, through market research and sound product and business development. Once markets and shops are developed, they can take over the continued promotion of sanitation infrastructure maintenance and improvements through their advertising campaigns. Entrepreneurs will be looking to make sanitation infrastructure a status symbol and economic market good.

## 2.2: Community-Led Total Sanitation in Mali

Dr. Kar traveled to Mali in March, 2009 for a workshop to introduce CLTS to government, NGO, and other sanitation sector partners from 10 Francophone countries throughout West and Central Africa. This workshop was mainly supported by UNICEF and included “hands-on” experience with implementing CLTS in communities in the area of Bamako, the capital city of Mali. As of January, 2011, a total of 169 villages in five regions have been certified ODF, in the process building nearly 9,000 latrines and a population of nearly 110,000 are now living in a certified ODF community (UNICEF - WCARO, 2011).

The CLTS campaign in Mali has been particularly successful for a number of reasons. First and foremost is the involvement of *griots*, traditional communicators and social leaders, in the triggering process. These *griots* are networked at the national level through the organization, RECOTRADE – traditional communicators' network, and have been trained in and involved with CLTS triggering from the beginning, making the triggering process much more effective through using traditional communications

methods. Secondly, media have been very supportive of the spread of CTLS throughout Mali, documenting CLTS interventions and broadcasting them at a national level. This greatly enhances the village pride felt from taking steps to and becoming ODF. Thirdly, political leaders from all levels of government and prestigious personalities have been involved in ODF celebrations, showing support for the program and again increasing community pride in becoming ODF. All this has added up to a very successful CLTS program throughout much of Mali (UNICEF - WCARO, 2011).

### 2.3: Project Sustainability

In recent years special emphasis has been placed on the sustainability of water and sanitation development projects (Jenkins & Sugden, 2006; McConville & Mihelcic, 2007; Montgomery et al., 2009; Schwietzer & Mihelcic, 2012). *Our Common Future* (Brundtland, 1987) defined sustainable development as, “development that meets the needs of the present without compromising the ability of the future to meet its needs.” Projects need to be designed in a way that not only the negative environmental, economic, and social impacts are minimized, but also the project needs to be such that it can be continued by the local population that is directly affected, ideally without long term outside input (be it technical, economic, or motivational). CLTS directly addresses each of these points of sustainable projects: environmental impacts, economic impacts, and social impacts.

#### 2.3.1: Environmental Impacts

Increasing sanitation coverage can have major impacts on environmental health, both positive and negative. Open defecation can clearly have a negative impact on environmental health, through increased nutrient load to sensitive watersheds and

creation of pest/insect breeding grounds. However, moving people away from open defecation might not be the solution to these problems. For example, if human excreta is simply collected and discharged without treatment, the results are the same.

This may be one area where CLTS can fall short. The focus of CLTS is on ending the hazardous to human health practice of open defecation, not on the building of sanitation infrastructure for the protection of the environment. That being said, moving people away from open defecation clearly also has a positive effect on environmental protection. While the certification of communities as ODF is the responsibility of local authorities and thus the criteria change in a case by case basis, emphasis is placed on the sanitation infrastructure being such that it does not simply move the pollution and waste downstream before a community can be certified ODF, thus protecting environmental health.

### 2.3.2: Economic Impacts

It is clear that the lack of access to basic sanitation has some very negative economic impacts on communities and countries around the world. For example, Hutton, et al. (2007) found that the four countries of Cambodia, Indonesia, the Philippines, and Vietnam lose US\$ 9 billion/year, based on 2005 prices, due to inadequate access to sanitation. The cost-benefit ratios of water and sanitation interventions around the world have also been shown to be quite high. Another study (Hutton & Haller, 2004) showed that the cost-benefit ratio for the WHO Region sub-Saharan Africa epidemiological pattern D (AFR-D), which includes Mali, for meeting the MDG target for water and sanitation was estimated at 9.93. The most pessimistic estimate of this value (highest

cost and lowest benefits) was 1.96, still significantly above 1.0, meaning the benefits outweigh the costs.

While it has been clearly shown that increasing access to improved water and sanitation services will increase the community-wide, country-wide, and world-wide economic sustainability, much emphasis must also be placed on water and sanitation projects themselves achieving economic sustainability. This will mean money for projects being used in the most effective and efficient ways, allowing for more projects with greater impacts. There has been much debate over whether CLTS allows for more economic sustainability in projects (Kar & Bongartz, 2006; Robinson, 2006; Kavarnstrom & McConville, 2007; Deak, 2008; Ahmed, 2009; Pattanayak, et al., 2009; Evans, et al., 2009; Hickling & Bevan, 2010; Luthi, et al., 2010; Sijbesma, et al., 2010; Zulu, et al., 2010; Harvey, 2011). This debate has been centered around the methodology of soliciting demand from the communities involved in sanitation projects. CLTS looks to create demand for sanitation through getting people to realize the dangers of open defecation and stop that dangerous practice, while the traditional approach has been to offer a subsidy (sometimes, but not always alongside educational programming) and have that create demand. Essentially this question boils down to: where is outside money best spent, on educational/behavior change activities that look to increase demand for sanitation or on hardware and incentives for individual families to build sanitation infrastructure?

#### *2.3.2.1: The Case for Direct Hardware Subsidies*

The argument for direct hardware subsidies to families is based on the argument for sanitation in general, but assumes that families are not able to provide for their own

sanitation infrastructure. In “Sanitation: A Human Rights Imperative” the argument is made that sanitation is a basic human right, and governments have a responsibility to provide basic sanitation services for everyone (COHRE, 2008). Many have argued that this means that governments should be directly supplying sanitation hardware through free or subsidized infrastructure provision projects (e.g. Evans, et al., 2009). The areas that are most affected by inadequate access to basic sanitation services are also the poorest areas of the world, and it is hard for poor families to invest significant amounts of money in sanitation. This is for a couple of different reasons. Firstly, the money for sanitation and hygiene infrastructure is simply not available for many poor families. Secondly, the advantages of access to sanitation are seen on a community-wide level. Individual families that may invest in sanitation do not see the benefits if the entire community does not decide to invest along with them. Even one person still practicing open defecation can make an entire village sick. Evans, et al. (2009) argues that all this adds up to hardware subsidies being morally and economically necessary to increasing sanitation coverage in the poorest areas of the world.

#### *2.3.2.2: The Case Against Direct Hardware Subsidies*

This side of the debate is essentially based on the fact that in most cases direct hardware subsidies have been implemented in an unsustainable and damaging fashion. Hardware subsidies in and of themselves are not sufficient means to create demand for sanitation coverage in communities. If people are building a latrine simply because someone told them to and offered them money for supplies, they are not likely to maintain and use that latrine for very long if at all. Also if people are forced to use a specific type of sanitation infrastructure that they do not want, do not understand, or

cannot maintain because of inflexibility in the subsidy program, the infrastructure will fall into disrepair or will not be used. Examples of hardware subsidies creating artificial demand can be found in, Evans, et al. (2009).

Hardware subsidies have also been found to often not target the population most in need of financial assistance, for example if only families that own their land can participate in a subsidy program (Brocklehurst & Janssens, 2004). Hardware subsidies may also have a negative effect on the demand for sanitation, through making people dependent on the subsidy. If people see that their neighbor was given a latrine for free or given the materials to build one, they are highly unlikely to build one for themselves, they will simply wait for one to be given to them. As projects of this nature often have limited scope, not reaching an entire population of an area or country, this creates entire communities of people waiting for someone to give them a latrine and reduces individual investment in sanitation to next to nothing. Examples of this are in Jenkins & Sugden, 2006 and Rodgers, et al., 2007.

#### *2.3.2.3: How Community-Led Total Sanitation Fits in the Picture*

The argument for and against subsidies is at heart a discussion on whether it is more important to focus on the “software” of education and behavior change activities or on the “hardware” of provision sanitation infrastructure. CLTS focuses on the “software” side of work in the sanitation sector, and proponents believe that it is only through these behavior change and education techniques that real demand for sanitation infrastructure can be created and through this creating this demand projects can move towards economic sustainability. The idea behind CLTS is that once people come to the realization that the practice of open defecation is dangerous and unacceptable in their

community, behaviors will change and demand for sanitation infrastructure will greatly increase. CLTS looks to solicit this real demand by not offering any hardware subsidies whatsoever. The people want to make the change and they themselves make it happen, no one is doing it simply to get a subsidy. The funding for CLTS interventions starts out slow with only a few CLTS trainers and facilitators being trained and triggering the first villages. After this initial phase, the natural leaders from the first villages will receive training and they will become responsible for the spread of CLTS throughout an area or a country. Funding will increase as CLTS spreads and more trainings are done, and as the first villages are certified ODF. While continuing trainings and triggering, funding must also be allocated for monitoring and evaluation, as well as, the author believes, into Sanitation Marketing programs, which will continue to promote sanitation improvements through marketing techniques and sanitation businesses.

### 2.3.3: Social Impacts

Many of the opponents of CLTS has argued that it shames people into building latrines, and does not appreciate the value of human beings and the infringes on people's basic human right to being treated with dignity and respect (Robinson, 2008). Reality could not be further from this argument. CLTS actually empowers people and enhances dignity and self-respect. The United Nations Statement of Common Understanding on the Human-Rights Based Approach (UN, 2003) states that:

*it is essential that people are recognized as key actors in their own development, rather than passive recipients...that participation is both a means and a goal...that the development process is locally owned...*

CLTS accomplishes all these goals. If the triggering process is done properly, the people are not degraded for practicing open defecation, they are simply helped to come to the realization of the dangers and negative effects of this practice.

CLTS is based on the concepts of collective dignity and self-respect. People are helped to see the direct negative effects of open defecation and are allowed to feel the filthiness of open defecation (Harvey, 2011). During “triggering” activities the disgusting nature of the practice of open defecation has a light shone on it, however the participants themselves are not actually called disgusting. They come to the realization of the disgusting and dangerous practice on their own, in this way their own sense of dignity and self-respect is also “triggered” and hopefully they decide to do something about it. It is the collective sense of the filthy and unsanitary nature of open defecation that comes from within the community that produces real, sustained behavior changes, not the external condemnation of a common practice. In order for CLTS to work, and when it is done right, the sense of shame comes from within the village and the change in behaviors does too.

This increases the social capital of the community. The pride that a community feels in becoming open defecation free is great, and it is celebrated by the CLTS process. Often women and school children play a large role in the CLTS process, serving on sanitation committees and working as “defecation monitors.” This helps to increase their social capital within the community as well (Kar & Bongartz, 2006; Pattanayak, et al., 2006; Bongartz et al., 2010.)

## 2.4: Willingness-to-Pay

Willingness-to-pay, also called contingent valuation, studies have been used for years in many different sectors to value products, services, and more intangible benefits. Many of these studies have focused on the valuation of non-market environmental benefits. In fact, willingness-to-pay studies were first developed in the 1940s to value the public good of the prevention of soil erosion (Ciriacy-Wantrup, 1947). Since then willingness-to-pay studies have evolved and been adapted to application in many different settings and sectors worldwide. These studies have been used in the health sector for valuation of mortality risk reduction (Mahmud, 2009), in the urban agricultural sector (Henn, 2000), and in both the developed and developing world. This thesis is mainly concerned with willingness-to-pay study application to the water and sanitation sector in developing countries. It was not generally accepted until the early 1990s that willingness-to-pay studies could be done in developing countries, it was believed the problems of asking hypothetical questions to low-income often illiterate participants were immense and that these studies should not even be attempted (Whittington, 1998). Now however, willingness-to-pay studies are common practice in project planning stages, assessing demand for a specific product or service, as well as when developing policies for pricing services and water resources protection (Carson & Hanemann, 2006). Several issues concerning the implementation of willingness-to-pay studies in the developing world still exist, and careful study design is necessary to produce significant results.

### 2.4.1: Biases and Willingness-to-Pay Elicitation Questions

There are many different biases that could be felt by the participants and affect the way they answer willingness-to-pay questions. Strategic bias happens when the

participant believes that in giving a misleading answer to willingness-to-pay questions, they will be able to advantageously affect the eventual price of the product or service in question. Strategic bias can work in two ways, “free riding” and “over-pledging” (Mitchell & Carson, 1989). When a participant is “free riding” they tend to undervalue the good or service in question with the expectation that this will make the eventual price lower. “Over-pledging” occurs when a participant assumes that his/her stated willingness-to-pay will influence the provision of the good or service in question (Venkatachalam, 2004). For example, if an NGO finds that the construction of a safe, hygienic latrine is cost prohibitive, because the participants over-pledged, and decides to offer free or subsidized latrines.

Hypothetical bias in two different ways, when a participant does not understand or cannot conceptualize payment for the product or service in question or when a participant does not give the willingness-to-pay elicitation question much thought and simply states the first answer that comes to mind. A balance must often be struck between minimizing hypothetical bias and strategic bias. For example, Whittington et al. (1993) allowed some participants more time (1 day) to think about their responses to the willingness-to-pay questions. It was concluded that in the participants that were given time to think, hypothetical bias was low because they had sufficient time to understand the service in question and give it sufficient thought. However, strategic bias was likely high, as the participants had more time to figure out how to act strategically.

There are four main types of elicitation questions for willingness-to-pay data (Boyle, et al. 1985). These are structured bidding games, payment card, open-ended, and dichotomous choice. There are advantages and disadvantages to each, and much

contention over which is the best method can be found in the literature (Arrow, et al., 1993; Onwujekwe, 2004; Venkatachalam, 2004; Carson & Hanemann, 2006). The bidding game format, uses a set of structured bids and yes/no questions to evaluate them. For example, “would you be willing to pay X for product Z?” If the answer is yes, the bid is slightly increased, “would you be willing to pay X+Y for product Z?” The payment card method can be used in written surveys, the participants given a card with a list of prices and they check which one they would be willing to pay for the product or service in question. The open-ended question format is when a participant is simply asked, “how much would you be willing to pay for product X?” The dichotomous choice method is when a specific product or service at a specific price is compared to another similar product or service at a specific price, and the participants chose which one they are more likely to purchase. For example, “would you be more likely to connect to a private water system with quality X, hours of operation Y, and month price Z or purchase water from a tap-stand with quality A, hours of operation B, and price per bucket C?” In general, the only agreement in the literature about which elicitation method should be used has been that it should be the one that most closely resembles the actual market or purchase conditions of the product or service in question (Whittington, 1998; Onwujekwe, 2004; Venkatachalam, 2004; Carson & Hanemann, 2006).

### **Chapter 3: Methodology**

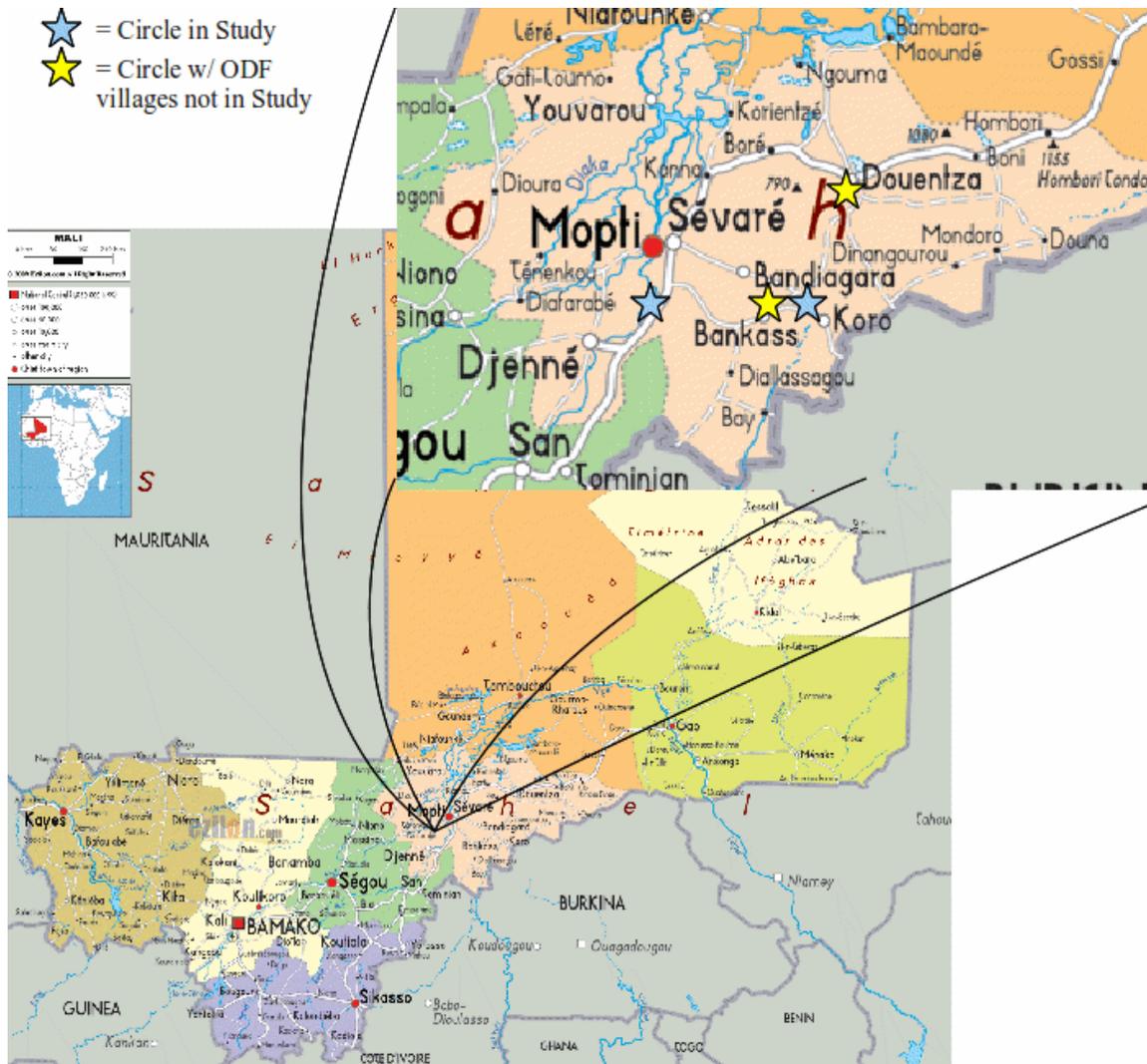
As discussed in previous chapters, the objectives of this research are to assess the implementation of CLTS and find possible correlations between socioeconomic data and willingness-to-pay for sanitation infrastructure in open defecation free (ODF) villages in the Mopti region of Mali, West Africa. This was done through a willingness-to-pay study that consisted of a questionnaire administered in 95 households in 6 villages throughout the region.

#### **3.1: Study Location**

Mopti region<sup>4</sup> is located in central Mali, and is located in the Sahel zone of northern Africa. The Sahel is the transitional zone between the Sahara desert to the north and the Sudanian Savanna to the south. Mopti is on the northern edge of this zone, being bordered in the north by the region of Tombouctou, to the south and west by the region of Segou, and to the south and east by the Burkina Faso. Mopti is dominated geographically by the inland Niger river delta, the Dogon Plateau, and the Bankass plains below the Bandiagara Escarpment. The population consists of ethnic Bambara, Peulh (Fula), Dogon, Bozo, and Songhai. Traditionally the Bambara, Dogon, and Songhai groups are farmers, the Peulhs are herdsman, and the Bozos are fishermen on the Niger. Major cities in the region are Mopti, Sevaré, Bandiagara, Bankass, and Djenne. See Figure 3.1 for a map of Mali, Mopti region, and the cities mentioned.

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<sup>4</sup> Regions in Mali are the third level of governmental administration, analogous to states in the US.



source: <http://www.ezilon.com/maps/africa/mali-maps.html>

**Figure 3.1:** Map of Mali showing Mopti region and study area.

CLTS was introduced in November 2009, with a training of facilitators hosted by UNICEF and Mali's National Directorate of Sanitation and Pollution Control (DNACPN) in Sofara, Djenne Circle.<sup>5</sup> The training was attended by representatives from many non-governmental organizations (NGOs), international development organizations<sup>6</sup>, government agencies, and health care workers in the area. At the time of the study, there were 21 total triggered villages and 17 total open defecation free (ODF) villages in Mopti

<sup>5</sup> Circles are the second level of local governmental administration, analogous to counties in the US.

<sup>6</sup> The lead author of this thesis attended this training as a representative of US Peace Corps.

region, of these only 3 had been certified. The remaining 14 villages were in the process of being certified and waiting on local officials to schedule certification ceremonies. For the purpose of this research, 6 villages were chosen, 3 of which were certified ODF and 3 of which were still in the certification process. These villages were chosen based on ease of access (villages were within 15km of circle capital and on roads passable by motorcycle) and the study team's familiarity with the village. The 6 villages that were chosen were Ene and Bama, both in the circle of Koro, and Abdoul-Karim, Biba, Diaba-Peuhi, and Diongue-Bambara, all in the circle of Djenne. Figure 3.1 shows a map of Mali, with a close-up of Mopti region, with the two circles where study villages were located marked.

After CLTS was introduced to Mopti in November 2009, the village sanitation committees that were formed in the first 15 triggered villages and the natural leaders from those villages took over responsibility for making the communities become open defecation free. In some of the triggered villages, notably Ene which was included in the research study, teams of masons were formed that constructed concrete latrine slabs, often having materials for the slabs being donated or subsidized by an outside organization, in the case of Ene it was WaterAID. While this is not what is recommended by CLTS experts (Kar & Chambers, 2008; Harvey, 2011), and cannot be called “pure” CLTS because a subsidy was offered, it was the village itself that initiated the project and this demand for sanitation infrastructure was created by the CLTS intervention. The community as a whole decided to make the positive behavior change to move away from open defecation, and sought-after the subsidized approach that they felt best helped them as a community to reach ODF status.

Over approximately the next year, the first 15 triggered villages worked on building latrines and attaining the goal of ODF status. By the end of 2010, these villages, all located in the circle of Djenne, realized that goal. However, the process of certifying these villages as ODF has been slow and not completed. At the time of the research, only the 3 study villages of Diongue-Bambara, Abdoul-Karim, and Biba had been certified as ODF in Mopti. The rest should be certified during the hot season of 2012, typically this is the time when the seasonal work schedules of villagers provide free time to accommodate a large official ceremony that results in the official declaration of ODF status. Hot season typically lasts from the beginning of March through June, when the rainy season starts.

After the first training of facilitators and triggering of villages in November, 2009, there had been only 6 other villages triggered. Two of these villages were in the circle of Douentza and they were triggered in January, 2010. Another 2 villages were in the circle of Koro and they were triggered in January, 2010 as well, both of these villages were included in this research study. A third set of 2 villages were triggered in May, 2010 in the circle of Bankass as well. Each of these circles are marked on the map of Mopti region in Figure 3.1. Data were not available on whether the villages in Douentza and Bankass had reached ODF status at the time of the study, but the villages of Ene and Bama in the circle of Koro had reached ODF status and were included in this research. These two villages were also waiting until the hot season of 2012 to perform a certification ceremony.

The main research instrument, a questionnaire, was completed with participants in the 6 study villages in October – November, 2011. The study team traveled to each of the

6 villages and completed the questionnaire with a total of 95 participant families over a 3 week period.

### 3.2: Study Design

In the design of a questionnaire to address the stated thesis objectives, the lead author of this thesis looked to the existing research and previous willingness-to-pay studies, and determined that the main indicators that correlate to willingness-to-pay are: 1. economic status, 2. education level, 3. age, 4. gender, and 5. understanding of the service being offered (Whittington, 1998; Venkatachalam, 2004; Carson & Hanemann, 2005; Gunatilake, et al., 2006). It was determined by the lead author of this thesis and study partners that the effects of gender on willingness-to-pay were beyond the realm of this research study, as the cultural background of rural Mali is such that it would be overly difficult to get enough women participants for the study to achieve statistical significance. This was indeed the case, as in one village (Abdoul-Karim) the study team was not allowed into about half of the family compounds of participants, for the stated reason that we were not allowed to see or speak to the women in the family.

The study partners in this research study assisted the lead author of this thesis with the development and implementation of the main study instrument, the willingness-to-pay questionnaire. US Peace Corps staff were integral to the process, providing assistance with translation of the questionnaire into French and development of the content of the questionnaire. UNICEF staff in both the capitol, Bamako, and regional representatives in Mopti also assisted with the development of the questionnaire, meeting several times with the lead author to help write questions, clarify research objectives, and arrange for questionnaire implementation. UNICEF also provided funding for

transportation and per diem for the study enumerators, alongside other logistical support of the questionnaire. Staff of the Malian *Direction Nationale de Assainissement et Contrôle des les Pollution Nuisances* (DNACPN, National Directorate of Sanitation and Pollution Control) and Mopti *Direction Régionale de Assainissement et Contrôle des les Pollution Nuisances* (DRACPN, Regional Directorate of Sanitation and Pollution Control) also assisted with the development of the questionnaire, providing insight into sanitation sector work in Mali as well as revision and eventual approval of the questionnaire. DRACPN staff also acted as translators and enumerators, giving the questionnaire in all 6 study villages.

In order to ensure accuracy in this research study, the main study instrument, the questionnaire, was designed to minimize common shortfalls in willingness-to-pay studies and with cultural sensitivity in mind. For example, it is culturally inappropriate to ask anyone direct questions about cash assets or earnings. Asking questions of this nature would only result in inaccurate answers and the participant mistrusting the study team, thus negatively affecting the remainder of the questionnaire or possibly discontinuing the questionnaire with the participant or the village in general. Thus, the economics section of the questionnaire was designed to provide a relative indication of the family's wealth through asking about their main sources of income without getting into specific cash amounts, assessing where their money is spent (e.g., motorcycles, televisions, cell phones), and assessing non-cash holdings (e.g., granaries, livestock).

Cultural appropriateness was also a major consideration in designing the willingness-to-pay section of the questionnaire. Much has been written on the common biases and inaccuracies in willingness-to-pay studies (see Boyle, et al., 1985;

Whittington, 1998; Henn, 2000; Onwujekwe, 2004; Venkatachalam, 2004; Carson & Hanemann, 2005). Strategic bias occurs when a participant feels that giving an inaccurate answer will beneficially affect the eventual valuation of the product or service in question. In order to counteract this bias, it was made clear to each participant that the study was purely for academic purposes and that their answers would in no way affect the services offered by the study partners, namely US Peace Corps, UNICEF, and DRACPN. Hypothetical bias occurs when either the participant does not fully understand the product or service in question (e.g. the environmental health benefits from removing pharmaceuticals and personal care products from wastewater) or the participant will not take the question seriously and answer without giving it sufficient thought. The specific willingness-to-pay questions were broken down into the most simple components in order to increase understanding of the product. For example, the participants were asked how much they would be willing to pay for a pre-manufactured concrete slab as an improvement to an existing latrine. The principal investigator, also the main author of this thesis, directly observed each questionnaire and carefully trained each enumerator to ensure understanding of the purpose of the questionnaire and accuracy of translation. This served to minimize the occurrence of hypothetical bias as well as non-neutrality bias, which results from the willingness-to-pay questions being asked in a way that may lead participants to a particular response.

Willingness-to-pay questions are typically asked in three formats, open-ended questions, dichotomous choice, and bidding-game. There is much contention in the literature over which of these type of questions produce the best results. Whittington, et al. (1990) found that the bidding-game format gave the best results, while Onwujekwe

modified the bidding-game slightly to simulate market conditions in Nigeria, and Gunatilake, et al. (2006) used the dichotomous choice method. In general it is suggested that the elicitation method chosen should be the one most closely resembling actual purchase conditions in the local context (Carson & Hanemann, 2005). Through discussion with study partners, pre-testing the questionnaire<sup>7</sup>, and the main author's familiarity with the culture, iterative-bidding elicitation method was chosen for this research study. This method, however, can produce starting-point bias, which occurs when the participant assumes that the starting price is a clue to the actual price. Many studies have shown that when doing willingness-to-pay studies for products or services in the water and sanitation sector, this bias has been minimal (notably Whittington, et al., 1990). Although starting-point bias was not specifically tested for in this research study, careful enumeration of the questionnaire and understanding of the purpose of the question by the translator and the participant likely mitigated the occurrence of this bias.

The sample size for this study was based on the number of households in each community. The target sample size was 15 households per village, however, in the largest village, Ene, the study team gave 20 questionnaires to be more representative of the village population. The target sample size was based on accepted willingness-to-pay methods in developing countries (Whittington, 1998). This was attempted in the next two largest villages, Diaba-Peulh and Diongue-Bambara, as well; however, the study team found it difficult to find household heads or qualified representatives present because the team was there during harvest. The questionnaire was administered in 95 (62.91% ) households throughout the 6 villages. These households had a combined

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<sup>7</sup> Pre-testing of the questionnaire was done in the village that the lead author of this thesis, a Peace Corps volunteer, had been living in for two years.

population of 2580 (54.45%). Table 3.1 is a sample break-down on a village by village basis.

**Table 3.1:** Sample size by village

Village	Households in Study	Total Households	%	Population in Study	Population	%
Abdoul-Karim	15	24	62.50%	457	725	63.03%
Bama	14	18	77.78%	356	460	77.39%
Biba	15	19	78.95%	329	417	78.90%
Diaba-Peulh*	16	27	59.26%	327	1128	28.99%
Diongue-Bambara	15	31	48.39%	453	944	47.99%
Ene	20	32	62.50%	658	1064	61.84%
Total	95	158	62.91%	2580	4738	54.45%

*\*Diaba-Peulh is made up of 3 separate small villages. The population number is for these 3 villages combined, however, only one of these villages made up of 27 households was included in the study. The difference is between the official government administration and local village chiefs.*

Within each village a stratified random sampling procedure was employed.

Within the Malian cultural context it was necessary for the study team to first visit the village chief's house for a small introduction and statement of purpose meeting with the village chief and some of the important figures in the village. After this meeting, the study team asked for a few well-respected individuals from the village to act as guides in selecting households to include in the study. These guides, which are also necessitated by the Malian cultural context, were instructed to take the study team to a stratified random sample of households. For example, in Ene, there were 4 distinct neighborhoods with approximately the same number of households/neighborhood. The target sample was 20 households out of the 32 total, so the guides were instructed to take the team to 1 small family, 3 medium families, and 1 large family within each neighborhood.

### 3.3: Questionnaire Summary

In order to answer the research questions previously discussed, a questionnaire was developed to be given in the study villages. This questionnaire was developed by the main author of this thesis with the assistance of the study partners and USF faculty. The questionnaire can be found in both English and French in Appendix A and B respectively.

The first three sections were used to clearly define the socioeconomic status and water, sanitation, and hygiene practices for the participant family. The fourth section is the collection of the willingness-to-pay data and the assessment of the importance of sanitation infrastructure in the participants daily lives. The purpose of the first three questions was to show if investment in sanitation infrastructure and hygiene is a priority in terms of allocation of discretionary income and under normal family budgeting situations. The fact that many of participants may or may not have experience with discretionary income or budgeting should not matter, since the questions were developed with the assumption that they do not have any experience in mind. Thus, the questions were made as simple and easy to quickly comprehend, process, and give answers as possible.

For example, within the Malian cultural context it would be difficult to answer a question such as, “if after buying enough food to feed your family for a month, you have \$100 leftover, how would you spend that money in each of these categories?” Instead, the question became, “these 20 beans represent the money you have leftover after buying enough food to feed your family for the month, do you spend these beans on...” In this way, the participants had something to actually allocate to each of the categories offered for discretionary income. Pretesting showed that Malians are very visual people and it

was much easier for them to allocate beans into categories than it would have been to put imaginary hypothetical cash into budget lines. This way of questioning also helps in that the discussion of the actual price of each of the categories did not have to factor in, the participants simply stated the proportion of their disposable income they would spend on each category, thus indicating its importance to them.

The second and third questions had participants rank the importance of certain essentials and proposed improvements respectively. In these questions a technique called “pair-wise” ranking was used to rank each option presented. Figure 3.2 shows an example of “pair-wise” ranking. First the participants were asked to select their top 5 choices from a list of ten. The first of these choices was then compared to the second and the participant picked out one. The “winner” of the first pair is then compared to a third option. If the same option is chosen, it is ranked 1 and the “loser” in the first and second pairings are compared, the winner being ranked 2 and the loser being ranked 3. This process continues until each of the top 5 options are ranked. This is a very simple and

Tom has to rank 5 options: A, B, C, D, and E.  
First, he compares A to B and chooses A.  
Next, he compares A to C and chooses A again.  
Thirdly, he compares B to C and chooses C.  
In A vs. D, he chooses D. In D vs. E, he chooses D.  
Thus, D is 1. Now, in A vs. E, he chooses A, so A is 2.  
Now in E vs. C, he chooses E, and he is finished.  
The ranking is: D – A – E – C – B

**Figure 3.2:** “Pair-wise” ranking example.

interactive way to rank options quickly and effectively. This same process was used in questions Q4-2, Q4-3, Q4-6, and Q4-7.

For the actual willingness-to-pay questions the iterative bidding method was used to find the participants willingness-to-pay values for each specific latrine construction and maintenance component. In this method, the enumerator asks if the participant would be willing to pay a specified amount for each component. If the answer is “yes,” the enumerator will increase the bid by a specified amount, in this case 500f CFA (approximately US \$1), until the participant answers “no,” he/she would not pay the asked amount. Most of the participants caught on quickly to this technique and instead of answering repeated questions with “yes” or “no,” they simply stated the maximum amount that they were willing to pay for each component. If they were not willing to pay the starting bid price, the bid was decreased by 500f CFA and repeated. The specific construction and maintenance components and corresponding starting bids in this study are tabulated in Table 3.2.

**Table 3.2:** Willingness-to-pay latrine components and starting bids

Construction Component	Starting Bid	Maintenance Component	Starting Bid
Cement and rebar to build a slab	5000f CFA	Emptying the pit/reconstruction when full	5000f CFA
Lining/sealing the pit with cement	5000f CFA	Soak-pit maintenance	2000f CFA
Thatched Roofing	1000f CFA	Super-structure maintenance	2000f CFA
Metal Roofing	7000f CFA	Soap for hand-washing (price per month)	2000f CFA
Soak-pit	5000f CFA		
Pre-manufactured slab	6000f CFA		
Cement bricks for privacy shelter	10 000f CFA		
Ventilation Pipe	2500f CFA		

The final question of the survey was to assess the reasons for non-adoption of latrine use. The provides valuable insight into the barriers that exist to adoption of latrine

use and the move away from open defecation. Asking this specifically to people who have made the choice to become ODF provides the added insight of the “been there, done that” effect. The participants in this study were mostly practicing open defecation no more than 2 years ago, and who better to know what stops people from using latrines than people who have made that very decision?

### 3.4: Human Subjects and Data Considerations

This research study was submitted to the University of South Florida Institution Review Board (IRB) as human subject research on September 3<sup>rd</sup>, 2011. The study was approved by the Department of Civil and Environmental Engineering on December 6<sup>th</sup>, 2011 and received by the university IRB on December 9<sup>th</sup>, 2011. On January 20<sup>th</sup>, 2012, the university IRB met and determined the study did not increase risk to subjects and that the data collected in this study could be used for the purposes of this thesis (see Appendix C for letter from IRB).

The data collected in this study was recorded on blank copies of the questionnaire with each family and converted to electronic format, the hard copies being stored by the lead author and the electronic copies being stored on a password protected computer and backed up on a secure internet cloud and external memory device that is keep with the hard copies. This data will be stored for the 6 years required by the University of South Florida's human subject research policy.

## Chapter 4: Results and Discussion

### 4.1: Existing Water, Sanitation, and Hygiene Behaviors and Conditions

Section 3 (see Appendix A for details) of the questionnaire collected baseline data on the water, sanitation, and hygiene situation on the ground in the study villages. The 95 families that participated in the survey owned a total of 186 latrines, of these 153 (82.3%) met the Malian government's criteria for basic sanitation.<sup>8</sup> The main reasons for a latrine to not meet this criteria was that 1) at the time of the questionnaire there was no cover for the defecation hole (n = 15, 8.06%) or 2) the cover for the defecation hole was not properly placed over the hole (n = 5, 2.69%). Most of the latrines were very basic and constructed of local materials. Basic mud and stick slabs were the most common observed (n = 90, 48.4%). Concrete slabs were the second most common (n= 69, 37.1%), the remaining (n = 27, 14.5%) being slabs made mainly of mud but having a thin layer of concrete to improve ease of cleaning and durability. Nearly a third of all latrines in the study villages (n = 55, 29.6%) had concrete slabs that were donated or subsidized by various groups working in the water, sanitation, and health sectors (e.g., the local community health clinic (CSCOM), WaterAID). Almost all of the latrines were constructed with a mud and/or rock privacy shelter (n = 177, 95.2%), only a few (n=9, 4.84%) had a thin layer of concrete over the mud and/or rock walls to improved durability. A few of the latrines had a soak-pit attached (n = 16, 8.60%). Soak-pits are

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<sup>8</sup> The criteria for basic sanitation is that, “having a slab that is sufficient to separate people from contact with excreta, provided with some mechanism to stop the spread of flies (e.g., covered defecation hole or ventilation), as well as a superstructure that will provide sufficient privacy.” This is the Malian governmental definition of basic sanitation, as laid out by National Directorate of Sanitation and Pollution Control (DNACPN) representatives at the AfriSan3 Conference in Kigali, Rwanda, July 2011.

important because they help to improve infiltration of wash-water, urine, and other water that flows off of the latrine slab, through a short pipe, into a small covered pit filled with porous rocks, and not directly into the latrine pit. Most of the latrines (n = 166, 89.3%) were constructed by the participant family themselves utilizing predominately local materials. In this way, many of the participants built their own latrines in very innovative ways, using local materials to keep the original cost of construction low. The data on the types of existing latrines and methods of construction is provided in Table 4.1.

**Table 4.1:** Current state of sanitation infrastructure. Averages across the 6 sample villages

Total # of latrines:	186	Total # meeting criteria for basic sanitation, number (% of Total):	153 (82.3%)
<b>Construction Components Used</b> number (% of total)			
Mud slab:	90 (48.4%)	Mud slab with concrete:	27 (14.5%)
Concrete slab paid for in full by participant:	14 (7.5%)	Concrete slab donated or subsidized:	55 (29.6%)
Mud privacy shelter:	177 (95.2%)	Mud with concrete privacy shelter:	9 (4.8%)
Soak-pit:	16 (8.6%)		
<b>Method of Construction</b> number (% of total)			
Self-built using mainly local materials: <sup>9</sup>	166 (89.3%)	Self-built using mainly imported materials: <sup>10</sup>	8 (4.3%)
Paid to have built using mainly local materials: <sup>11</sup>	7 (3.8%)	Built by a village organization:	1 (0.5%)

One example of innovative latrine design commonly observed in this study, was that households would line the latrine pit with mud bricks, building the bricks into a domed shape, the top of which formed the latrine slab. A hole was left at the top of the dome for use as a defecation hole, and the area outside of the dome was back-filled with

<sup>9</sup> Local materials consist of mainly mud, rocks, sticks, grass thatching materials that can be found in or harvested from the local environment.

<sup>10</sup> Imported materials consist of mainly cement, rebar, metal roofing, materials that have to be purchased.

<sup>11</sup> Of these two participants reported paying masons to build their latrines in cash and five reported paying “in kind” mainly with room and board.

soil, leaving only about 6 – 8 inches of the dome exposed that became the latrine slab. The privacy shelter was then built as large as the family desired around the exposed part of the dome and back-fill soil. Many of the participants that built their latrines in this way also placed a thin layer of concrete within the privacy shelter in order to make cleaning the surrounding floor easier and the exposed part of the dome and defecation hole more durable.

Fifty-three percent of the latrines (n = 98) were built completely free of cost. Eighty-eight latrines were paid for at least in part for materials or labor that went into latrine construction, the average amount paid for a latrine was 6078f CFA or about US \$12.96. The average amount paid for each construction component, among those that paid at all for that specific component is recorded in Table 4.2. The most expensive latrine component was found to be the digging of the pit, with an average of about 6100f CFA (US \$13.01) for the 23 latrines that participants paid for the digging of the pit. Sixty-one of the participants (64.2%) reported that they had previously performed maintenance or improvements on their latrine(s). The maintenance performed was typically rather simple involving putting a new layer of mud on the privacy shelter walls or replacing a broken defecation hole lid. The average cost of the performed maintenance was 720f CFA or approximately US \$1.54. These maintenance costs are also shown in Table 4.2.

When study participants were asked about making future improvements to their latrine most said that either future improvements were not required (n = 40, 43.5%) or they lacked the funds for future improvements (n = 39, 42.4%). This suggests that the original construction of the sanitation infrastructure was recent enough that the latrines

had not yet fallen into disrepair and the participants believed that the quality of their current latrine was sufficient. In the few case that the participants latrines had collapsed (n = 4, 4.21%) they had access to a neighbor's latrine that they were using until the harvest season was over and they would have the opportunity to rebuild.

**Table 4.2:** Construction costs and costs of maintenance performed before the time of the questionnaire. Costs are reported as an average cost of those that were purchased (0 costs not figured into average)

**Construction Component Costs**

Component	Cost in f CFA (US \$)	Number reporting any cost (% of total)
Pit	6100 (13.01)	23 (12.4%)
Slab	4530 (9.66)	74 (39.8%)
Privacy Shelter	4070 (8.68)	14 (7.5%)
Masons	1250 (2.67)	2 (1.1%) <sup>12</sup>
Total <sup>13</sup>	6080 (12.96)	88 (47.3%)

**Previously Performed Maintenance Costs**

Average cost of performed maintenance in f CFA (US \$) <sup>14</sup>	Number reporting any cost (% of total participants)	Number reporting performing maintenance at no cost (% of total participants)
720 (1.54)	16 (16.8%)	45 (47.4%)

Many of the participants (n = 45, 47.4%) reported that they were treating their drinking water at the point of use. Of these participants 57.8% (n = 26) reported using bleach for treatment, 22.2% (n = 10) reported using Aquatabs,<sup>15</sup> and 11.1% (n = 5) reported using either bleach or Aquatabs based on availability. The most used sources of drinking water were communal wells, with 34 participants (35.8%) reporting mainly

<sup>12</sup> Five others reported paying masons “in kind” to build their latrines.

<sup>13</sup> Total cost was calculated by summing the cost of each component for each latrine that the participants reported paying for, thus this is the average total cost/latrine of the latrines that participants reported a cost for in part or in whole.

<sup>14</sup> Those that reported performing maintenance at no cost are included in this average, thus this is the average total cost of maintenance of those that reported performing maintenance, not just those that reported paying for maintenance.

<sup>15</sup> Aquatabs is the brand name of the most common iodine tablets that are sold throughout Mali for treatment of drinking water.

using a communal uncovered well and 15 participants (15.8%) reporting mainly using a communal covered well. A few of the participants had private wells that they were using as a primary source of drinking water, with 7 participants (7.4%) reporting using a covered well and 9 participants (9.5%) reporting and uncovered well. A couple of the study villages, namely Ene, Diaba-Peulh, and Biba had communal hand pumps and thus most of the people in those villages used these as their families' main source of drinking water, totaling 30 participants (31.6%) in the total sample.

Data were also collected on the hygiene behaviors of the participant's families. A majority of the participants (n = 66, 69.5%) reporting using soap for hand-washing at critical times. These critical times were defined by the participants themselves. Eighty-one participants (85.3%) said that after using a latrine was a critical time that they washed their hands. Almost all of the participants (n = 92, 96.8%) reported that they wash their hands at the critical time of just before eating. A few of the participants also mentioned that they wash their hands before preparing food (n = 5, 5.3%), when bathing (n = 14, 14.7%), after cleaning up their child's feces (n = 10, 10.5%), at prayer times (n = 11, 11.6%), and after working (n = 1, 1.0%). While the incidence of participants mentioning that they wash their hands before preparing food and after cleaning up their child's feces was lower than expected, this may be explained by the fact that all but one of the participants in the questionnaire were male and those particular roles are typically performed by females in the Malian cultural context.

#### 4.2: Economic Data Analysis

As described in Chapter 3, the assessment of each household's economic status was based on a series of questions evaluating their income sources and possessions that

indicate wealth. A score (1 - 5) was given for each reported item within each category, based on the participants being within a range of “well below average (1),” “below average (2),” “average (3),” “above average (4),” or “well above average (5).” Each of the reported items and the ranges for classification are tabulated in Table 4.3.

The lead author of this thesis worked with representatives from US Peace Corps and United Nations Children's Fund (UNICEF) to develop the process for economic scoring drawing on local knowledge of the rural Malian economy. The specific sources of income and possessions that indicate wealth that the questionnaire looked for were based on the work in the field of sustainable livelihoods by Brock (2000) in rural Mali, Scoones (2002) in Mali, Ethiopia and Zimbabwe, and Wooten (2003; 2009) in rural Mali, as well as, Lay, et al. (2009) work on income diversification in neighboring Burkina Faso.

For analysis, each item that contributed to a source of income or possession that indicated relative wealth were classified and scored to obtain a numerical value between 1 and 5. These scores were then averaged first within indicator categories as shown in Table 4.2 (e.g., transportation, animal raising) and then a total average score was calculated, by averaging the scores for each indicator. It is this total average economic score that was used in the regression analysis applied to the willingness-to-pay data that will be discussed in the next section. Although the ranges in Table 4.1 show non-whole numbers, the participants cannot report non-whole numbers of any of the items (e.g. 1.25 motorcycles), thus the range in which the number of items was reported was the classification that item received (e.g. 1 motorcycle was within the “average” range and scored a 3).

**Table 4.3:** Reported economic data. Each economic variable reported with mean, standard deviation, and ranges for classification and scoring, data from all 6 villages

Economic Indicators and Contributing Items	Mean (Standard Deviation)	Classification Ranges (Score)				
		Well below average <sup>16</sup> (1)	Below average (2)	Average (3)	Above average (4)	Well above average (5)
<b>Transportation</b>						
Motorcycles	0.968 (1.11)	<0.65	0.66 – 0.87	0.88 – 1.1	1.2 – 1.3	>1.3
Bicycles	2.02 (1.65)	<1.4	1.5 – 1.8	1.9 – 2.2	2.2 – 2.7	>2.7
Donkey/Horse Carts	1.75 (1.43)	<1.2	1.3 – 1.6	1.7 – 1.9	2.0 – 2.3	>2.3
<b>Animal Raising</b>						
Cows	13.5 (20.1)	<9.0	9.0 – 12	13 – 15	16 - 18	>18
Sheep	10.7 (9.65)	<7.2	7.3 – 9.7	9.8 – 11.8	11.9	>11.9
Goats	14.5 (11.5)	<9.7	9.8 - 13	14 - 16	17 - 19	>19
Chickens	27.7 (20.5)	<18	19 - 20	21 - 25	26 - 37	>37
Donkeys	2.18 (1.71)	<1.5	1.6 – 2.0	2.1 – 2.4	2.5 -2.9	>2.9
Guinea Fowl	6.23 (13.0)	<4.2	4.3 – 5.6	5.7 – 6.9	7.0 – 8.3	>8.3
Horses	0.773 (1.28)	<0.52	0.52 – 0.70	0.70 – 0.85	0.85 – 1.0	>1.0
Camels	0.409 (0.783)	<0.27	0.28 – 0.37	0.38 – 0.45	0.46 – 0.55	>0.55
<b>Field Crops Sold</b>						
Millet	547 (887)	<360	360 - 490	490 - 600	600 - 730	>730
Corn	1.52 (12.3)	<1.0	1.1 – 1.4	1.5 – 1.7	1.8 - 2.0	>2.0
Sorghum	163 (235)	<110	110 - 150	151 - 180	181 - 220	>220
Rice	711 (963)	<470	470 - 640	641 - 780	781 - 950	>950
Fonio	37.9 (107)	<25	25 - 34	35 - 42	43 - 51	>51
Peanuts	327 (534)	<220	220 - 290	291 - 360	361 - 440	>440
Beans	327 (689)	<220	220 - 290	291 - 360	361 - 440	>440
Hibiscus	269 (1280)	<180	180 - 240	241 - 300	301 - 360	>360
<b>Granaries</b>	4.75 (4.56)	<3.2	3.2 – 4.3	4.4 – 5.2	5.3 – 6.3	>6.3
<b>Access to Media</b>						
Televisions	0.337 (0.612)	<0.22	0.22 – 0.30	0.31 – 0.37	0.38 – 0.45	>0.45
Cell Phones	2.46 (2.72)	<1.6	1.6 – 2.2	2.3 – 2.7	2.8 – 3.3	>3.3
Radio	1.45 (1.86)	<0.97	0.98 – 1.3	1.3 – 1.6	1.7 -1.9	>1.9

There were a few other indicators that the questionnaire tested for that are not included in Table 4.2, but were included in the overall economic score. About one-third

<sup>16</sup> “Well below average” is defined as more than 33% below average. “Below average” is defined as between 33% and 10% below average. “Average” is defined as within +/- 10% of average. “Above average is defined as between 10% and 33% above average. “Well above average” is defined as more than 33% above average.

(n = 30) of the respondents reported that a family member had job. These jobs were evaluated by the lead author, study enumerators, and UNICEF staff, drawing on their local rural economic knowledge to place each job in one of the five classification ranges (well below average, below average, average, etc.) and scored by classification. A few (n = 9) of the participants reported that they ran a village store. These stores were evaluated based on store size and merchandise. Small stores<sup>17</sup> were classified as “average” and given a corresponding score of 3. Medium stores<sup>18</sup> were classified as “above average” and given a corresponding score of 4. Large stores<sup>19</sup> were classified as “well above average” and given a corresponding score of 5. The classification and definitions of village stores were based on the local knowledge of the lead author, US Peace Corps staff, and UNICEF staff.

The participants were also asked if they received remittances from family members working outside the village or outside the country. Fifty of the participants reported receiving remittances, representing 52.6% of the sample population including all 6 villages. These were considered separately from the total economic score, mainly because it was difficult to classify the amount of remittances received and how much remittances contributed to household income. This is consistent with other willingness-to-pay studies done in developing countries (Whittington, et al., 1990; Gunatilake, et al., 2006; Pattanayak, et al., 2006).

The questionnaire also asked if the family sold items in market or in the village (aside from running a village store) and how their house was constructed. These items,

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<sup>17</sup> Small stores were defined as not having a separate building and minimal merchandise (e.g., tea and sugar, cigarettes, small candies, soap).

<sup>18</sup> Medium stores were defined as having a separate building and slightly expanded merchandise (e.g., that of a small store as well as, cooking oil, pasta).

<sup>19</sup> Large stores were defined as having a separate building and expanded merchandise (e.g., that of a medium store as well as, flour, rice, biscuits, batteries).

however, did not prove to be valid indicators and were not included in the overall economic score. The sales of items in market and village was determined by the study team and partners to be overly arbitrary and difficult to measure contribution to household economic status. This was because it is culturally unacceptable to ask about specific cash incomes from sales in market and village, thus only data on what was typically sold could be collected. Housing, while it can be an important indicator of wealth, was determined invalid, again by the study team and partners, because there was not enough variation in housing (89.5% of participants reported mud construction without improvement such as metal roofing or cement sealing of walls and/or floor).

It is important to note that this process of classification and scoring is based on the sample only. The scores for each income source and possession indicator are based on the averages of those items within the sample, thus the scores are relative to each other. For example, a total economic score of 3 indicates the participant is “average” relative to the sample population, not “average” relative to the entire population of Mali or worldwide. This is also true for each item and indicator tested for by the questionnaire. A person with a score of 4 for the transportation indicator has an “above average” number of combined transportation items (e.g., motorcycles, bicycles, donkey carts) relative to the sample, and a person with a motorcycle score of 5 has a “well above average” number of motorcycles only relative to the sample.

#### 4.3: Willingness-to-Pay Analysis

As described in the previous chapter, the willingness-to-pay data in this research study was collected through the iterative bidding method. This method typically yields a range of values within which is contained the participants willingness-to-pay.<sup>20</sup> However,

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<sup>20</sup> Because with each bid the participant has the option to say “yes” he/she would pay the bid price or

in this research study, the participants were asked if the last bid that they agreed to was the maximum amount of money they would be willing to pay and that maximum value was recorded. Thus, the data consists of point values represent the maximum amount each individual would be willing to pay for each latrine construction and maintenance component.

In order to test for correlations between willingness-to-pay values and socioeconomic data, the contingent valuation methods described in Whittington, et al. (1993) were used. This method derives each participant's willingness-to-pay as the difference between indirect utility functions at two different states of sanitation infrastructure quality.

As an example, let  $U( )$  be the participant's indirect utility function. This function is based on the quality of the specific construction or maintenance component ( $C$ ), participant assets ( $A$ ), amount set aside for planned infrastructure and livelihood investments ( $P$ ), and other socioeconomic characteristics which may affect taste ( $SE$ ). If the current sanitation infrastructure quality ( $C_0$ ) is to be improved to a state ( $C_1$ ) in which the specific latrine construction or maintenance component has been purchased, the difference must be the user's willingness-to-pay ( $WTP$ ) to realize that change. Therefore, the difference in the two utility functions at the unimproved ( $U_0$ ) and the improved ( $U_1$ ) state can be written as follows:

$$U_1 (P - WTP, C_1, A, SE) = U_0 (P, C_0, A, SE) \quad (1)$$

Equation 1 implies that  $WTP$  is a function of the change in  $C$ , as well as all the other factors that influence this change. Thus the  $WTP$  function can be written as:

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“no,” one can only know that the real willingness to pay lies between the bid amount for which the participant last said “yes” and the bid amount for which the participant said “no”. Thus there is a small range of values that the willingness-to-pay must lay within.

$$WTP = f(C_0, C_1, P, A, SE) \quad (2)$$

In this case, because the WTP data is in the form of the maximum (point) value that a participant would be willing to pay, the ordinary least squares (OLS) method of regression analysis was used (Whittington et al., 1993; Henn, 2000; Willis, 2002). Thus, the WTP was modeled as:

$$WTP_{OLS} = f(C_0, C_1, P, A, SE) + \varepsilon \quad (3)$$

where  $\varepsilon$  is the unexplained variances in the variables influencing the WTP function,  $f(\cdot)$ .

Table 4.3 presents each of the variables in Equation 3 and its proxy from the questionnaire data. The specific proxies used for each of the variables were based on a review of willingness-to-pay study literature (Boyle, et al., 1985; Briscoe, et al., 1990; McPhail, 1993; Whittington, et al., 1993; Atlaf & Hughes, 1994; Whittington, 1998; Pattanayak & Kramer, 2001; Whittington, 2002; Onwujekwe, 2004; Venkatachalam, 2004; Carson & Hanemann, 2005; Gunatilake, et al., 2006; Pattanayak, et al., 2006) and the local rural economy knowledge of the lead author and study partners.

The current state of sanitation infrastructure quality ( $C_0$ ) is defined by 3 parameters from the questionnaire data: the number of current latrines, the maintenance and improvements to the current latrines that have been made to date, and the original cost of the current latrines. Logically, one cannot predict the correlation of the current number of latrines and willingness-to-pay. It could be the case that the more latrines a family has, the less they are going to want to pay to improve each one. Contrarily, it is conceivable that the more latrines a family has, the more important sanitation is to them and they are likely to invest more. The available literature does not provide guidance in this area either, and so one cannot predict if the correlation will be positive or negative.

**Table 4.4:** Willingness-to-Pay function variables, proxies from questionnaire data, and expected correlations.

Variable	Description	Proxy (Short Hand)	Expected Correlation
C <sub>0</sub>	Current state of sanitation infrastructure quality	Current number of latrines (NUM) <sup>21</sup>	? <sup>22</sup>
		Previous maintenance and improvement of current latrine(s) (MAIN)	+
		Original cost of latrine(s) (COST)	?
C <sub>1</sub>	Improved state of sanitation infrastructure quality	Latrine construction or maintenance component being tested	N/A <sup>23</sup>
P	Planned infrastructure and livelihood investments	Proportion of disposable income allocated for sanitation from question #4.1 (PROP)	+
		Latrine rank from question #4.3 (RANK)	-
A	Participant's assets	Total average economic score (ECON)	+
		Remittances (REMIT)	+
SE	Other socioeconomic characteristics that may affect user preferences	Education (EDUC)	+

The same is true for the original cost of the latrine(s). In some cases in the literature, the cost of the current state of operation is negatively correlated to willingness-to-pay because the higher the current cost of water and sanitation products or services, the less likely people are to be willing to pay even more for a improved version of that product or service (Briscoe, et al., 1990; Gunatilake, et al., 2006). Contrarily, some studies have found that the current cost of water and sanitation products is positively related to willingness-to-pay (Whittington, 1993; Merrett, 2002), indicating the more people pay

<sup>21</sup> It was found that many of the families had multiple latrines, because often the households were quite large, sometimes having specific male and female latrines.

<sup>22</sup> A ? denotes that the sign of the correlation cannot be predicted from a review of literature and/or logic.

<sup>23</sup> Because the willingness-to-pay is tested for each specific state of improved sanitation infrastructure (e.g., a latrine with a pre-manufactured cement slab, or with a ventilation pipe), this is treated as a constant and thus has no correlation to willingness-to-pay.

for these products or services the more important they are to them and thus the willingness-to-pay is higher. We can expect that maintenance and improvements that the family has already done to their system will be positively related to willingness-to-pay, the more improvements they have already made, the more likely they are to pay more for more improvements.

In Equation 3 the variable  $C_1$  is the improved state of sanitation infrastructure. This is represented by the specific latrine construction or maintenance improvement being purchased and thus will be viewed as a constant for each of the different regressions for willingness-to-pay that are calculated. The construction or maintenance improvements that were tested are tabulated in Table 4.5.

The variable P in Equation 3 is the planned infrastructure and livelihood investments. In this case, the concern is for the proportion of these investments that go to sanitation infrastructure. The questionnaire data provides two different measures of this proportion. In question 4-1, the participants said how much of their discretionary income would be hypothetically allocated to each of ten different categories of investment and recurring purchases (see questionnaire discussion in Chapter 3). The specific proportion from this question that respondents allocated to investment in sanitation infrastructure was used in the regression analysis. We can expect a positive relationship with willingness-to-pay, as the proportion allocated for investment grows, so should willingness-to-pay. The data collected by question 4-3 was also included as part of the P variable from Equation 3. Question 4-3 had the participants rank the importance of investment in sanitation infrastructure from a list of ten possible infrastructure and choices, leaving five options unranked. In order to be conservative, if the sanitation

**Table 4.5:** Summary of each of the construction or maintenance improvement scenarios tested with average willingness-to-pay maximum values. In this question, the participants only ranked their top five willingness-to-pay values

Scenario	Construction or Maintenance Improvement	Average Willingness-to-Pay for entire sample reported in US \$
SLAB	Purchasing cement and rebar to construct a new slab for an existing latrine	16.07
PIT	Purchasing cement bricks for lining and sealing the pit for a current latrine	14.17
T-ROOF	Purchasing a thatched roof for a current latrine	4.35
M-ROOF	Purchasing a metal roof for a current latrine	16.26
SOAKPIT	Constructing a soak pit as an improvement to an existing latrine	11.38
PM SLAB	Purchasing a pre-manufactured latrine slab as an improvement to an existing latrine	13.02
SHELTER	Constructing a cement privacy shelter as an improvement to an existing latrine	22.52
VENT	Installing a ventilation pipe on an existing latrine	6.42
PIT-MAIN	Emptying the pit or filling in the pit and moving the superstructure of an existing latrine	12.33
SP-MAIN	Maintaining the soak pit <sup>24</sup> on a current latrine	4.84
SS-MAIN	Maintaining the superstructure <sup>25</sup> of an existing latrine	5.33
SOAP	Buying soap for hand washing on a monthly basis	4.34
T/S VIP	Building a new ventilated improved pit (VIP) latrine with a thatched roof and self-constructed cement slab	73.78
M/S VIP	Building a new VIP latrine with a metal roof and self-constructed cement slab	84.95
T/M VIP	Building a new VIP latrine with a thatched roof and pre-manufactured cement slab	70.71
M/M VIP	Building a new VIP latrine with a metal roof and a pre-manufactured cement slab <sup>26</sup>	81.87

<sup>24</sup> Soak pits require regular maintenance such as, cleaning the rocks and re-digging the pit to improve infiltration into the surrounding soil.

<sup>25</sup> Including cleaning the walls and slab, fixing cracks in both the walls and slab, replacing damaged bricks or roofing material, etc.

<sup>26</sup> The four VIP latrine options are composites based on the sum of the willingness-to-pay maximum

infrastructure option was left unranked, it was entered as a 10 (the lowest rank) for purposes of analysis. A negative correlation with willingness to pay can be expected. Higher rank is denoted by a lower number (1 being the highest and 10 the lowest), thus the more important investment in sanitation infrastructure, the higher the willingness-to-pay, and the lower the numerical value of rank.

The variable A in equation 3 is the participant's assets. This variable was defined in two ways based on the questionnaire data. First was the total average economic score discussed in Section 4.2. Second, was the reception of remittances by the respondent family. Both of these proxies can be expected to have a positive relationship with willingness-to-pay. It stands to reason that the more money that is available (e.g. higher economic score and reception of remittances) the more the participant would be willing to pay for improved sanitation infrastructure. This is supported by the literature on willingness-to-pay for water and sanitation services (Whittington, et al., 1990; Whittington, et al., 1993; Merrett, 2002; Cho, et al., 2005; Gunatilake, et al., 2006).

Other socioeconomic factor (SE) that factor into the willingness-to-pay formula is education level. The study team and partners (notably UNICEF, US Peace Corps, and Regional Directorate of Sanitation and Pollution Control (DRACPN) staff) as a result of pretesting the questionnaire and based on their local knowledge, decided that instead of collecting data on years of school attendance or grade reached, it would be more representative of the sample to measure the education level of a participant in 6 categories. These education level categories were: no schooling (recorded as a 1 in the data), started primary school (recorded as 2), finished primary school (record as 3), started secondary school (recorded as 4), finished secondary school (recorded as 5), and

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values of each component needed to build each type of VIP latrine.

higher education (recorded as 6). In the pretesting process, very low school attendance, the participant starting and stopping school many times, and the participant not remembering how many years of attendance or grade level reached caused the data to be overly disparate and difficult to collect. Education is expected to have a positive relation with willingness-to-pay, both because of the positive effect of education on economic status and the likelihood that with higher education the importance of sanitation infrastructure is more known. This is supported by the literature on willingness-to-pay for water and sanitation studies (Briscoe, et al., 1990; Whittington, et al., 1990; Whittington, et al., 1993; Merrett, 2002; Gunatilake, et al., 2006; Pattanayak, et al., 2006). Data were also collected on the education level of the female household head. The female household head is the wife, or one of the wives, that takes part in the family discussion on sanitation. These data were not included in the regression analysis, however, since only one respondent reported a wife attending any school at all. A few (n = 14) participants reported that they had attended Koranic school, but this was not included as well because of the focused religious educational nature of Koranic school in Mali. A few (n = 6) participants also reported that they are literate in *Bambara* and/or *Fulfulde (Fulani)*, the most commonly spoken local languages in Mopti. This was also not included in the regression analysis since it was not specifically asked for and was merely voluntarily offered additional information by a few participants.

Each of these proxies were put into the multivariate ordinary least squares regression. Using spreadsheet software and the LINEST() function the ordinary least squares regression model was calculated, correlations were found. Combined data from all 6 study villages were included in order to keep the sample size large enough for

statistical strength. Table 4.6 shows the results of the ordinary least squares regressions for each of the willingness-to-pay construction and maintenance components. Tables 4.7 – 4.22 show more detailed results of each regression model for each latrine construction and maintenance components tested, and Figures 4.1 – 4.16 show the strength of correlation found between each variable and willingness-to-pay for a specific latrine construction or maintenance component. The test for validity of each regression is done by looking at the t-statistic, its corresponding significance level, and the coefficient of multiple determination ( $R^2$ ). Based on accepted methods for contingent valuation (willingness-to-pay) studies only variables with t-statistics reaching at least a 10% significance level and regressions with an  $R^2$  value of at least 15% will be considered statistically valid (Mitchell & Carson, 1989; Whittington et al., 1993; Carson & Hanemann, 2005).

The t-statistic measures the contribution of each variable to the entire regression model, the higher the t-statistic value the more the variable contributes to the model. Thus, a higher t-statistic indicates a more statistically robust correlation, whether it be positive or negative, strong or weak. The significance level corresponding to the t-statistic tells us at what level of precision we can reject the null-hypothesis of the variable in question not contributing to the overall regression model. For example, for a t-statistic of 3.18, the significance level is found to be 0.25%, thus we know to within 0.25% precision that the null-hypothesis of the variable not contributing to the the overall regression model can be rejected. Thus, the lower the significance level, the more precise we can be with the rejection of the null-hypothesis, and the greater confidence we have in the specified variable contributing to the overall regression model. Significance levels

**Table 4.6:** Summary of the all of the ordinary least squares willingness-to-pay regression models. Showing each willingness-to-pay scenario, the R<sup>2</sup> value of the overall regression model, the correlation coefficients for each of the independent regression variables, and where to find more detailed results of the regression analysis

Scenario	R <sup>2</sup>	Correlation Coefficients with (t-statistic) <sup>27</sup>								More detailed results	
		NUM	MAIN	COST	PROP	RANK	ECON	REMIT	EDUC	Table	Figure
SLAB	10.3%	-0.35(-0.23)	-0.05(-0.22)	1.6(2.2)*	-0.59(-0.64)	0.41(0.27)	0.05(1.3)	-0.89(-2.1)*	0.46(0.58)	4.5	4.1
PIT	10.4%	-0.75(-0.70)	-0.26(1.6)*	1.1(2.0)*	-0.36(-0.55)	-0.36(-0.33)	0.02(0.86)	-0.56(-1.9)*	0.05(0.09)	4.6	4.2
T-ROOF	5.27%	-0.18(-0.21)	-0.04(-0.28)	0.80(1.9)*	0.24(0.46)	0.70(0.83)	-0.002(-0.09)	-0.14(-0.59)	-0.12(-0.28)	4.7	4.3
M-ROOF	7.00%	0.01(0.01)	-0.19(-0.98)	1.2(2.0)*	0.44(0.59)	0.39(0.32)	-0.01(-0.38)	-0.38(-1.1)	-0.52(-0.81)	4.8	4.4
SOAKPIT	7.39%	0.82(0.84)	-0.23(-1.6)	0.39(0.82)*	0.44(0.78)	0.37(0.38)	0.02(0.81)	-0.02(-0.07)	0.12(0.24)	4.9	4.5
PM SLAB	2.23%	0.10(0.13)	-0.02(-0.20)	0.09(0.23)	0.20(0.41)	0.54(0.69)	0.01(0.60)	-0.15(-0.69)	-0.02(-0.04)	4.10	4.6
SHELTER	6.93%	2.7(1.1)	0.28(0.69)	-0.26(-0.20)	2.0(1.3)	2.0(0.76)	0.05(0.71)	-0.19(-0.27)	-0.36(-0.27)	4.11	4.7
VENT	3.51%	-0.35(-0.43)	-0.02(-0.17)	-0.28(-0.69)	-0.36(-0.73)	1.0(1.3)	0.02(0.77)	0.01(0.03)	0.22(0.53)	4.12	4.8
PIT-MAIN	7.33%	0.08(0.07)	-0.002(-0.01)	0.29(0.55)	-0.19(-0.30)	0.60(0.57)	-0.003(-0.12)	-0.30(-1.0)	1.2(2.2)*	4.13	4.9
SP-MAIN	3.37%	0.24(0.50)	0.01(0.10)	-0.09(-0.38)	-0.20(-0.66)	0.32(0.67)	0.01(0.86)	-0.09(-0.69)	0.21(0.85)	4.14	4.10
SS-MAIN	5.56%	-0.54(-0.76)	-0.10(-0.95)	-0.27(-0.78)	-0.40(-0.92)	0.97(1.4)*	0.02(1.1)	0.03(0.18)	0.12(0.34)	4.15	4.11
SOAP	3.15%	0.08(0.24)	-0.01(-0.11)	-0.06(-0.36)	0.09(0.42)	-0.11(-0.33)	-0.01(-0.60)	0.06(0.65)	0.16(0.93)	4.16	4.12
T/M VIP	3.89%	2.4(0.42)	-0.30(-0.35)	1.8(0.65)	2.1(0.62)	4.3(0.75)	0.11(0.80)	-1.1(-0.67)	-0.11(-0.04)	4.17	4.13
M/M VIP	4.11%	2.6(0.44)	-0.45(-0.51)	2.3(0.79)	2.4(0.66)	4.0(0.68)	0.10(0.71)	-1.3(-0.81)	-0.51(-0.17)	4.18	4.14
T/S VIP	4.88%	1.9(0.31)	-0.33(-0.35)	3.4(1.1)	1.4(0.37)	4.1(0.68)	0.15(0.99)	-1.8(-1.1)	0.36(0.11)	4.19	4.15
M/S VIP	5.13%	2.1(0.34)	-0.48(-0.50)	3.8(1.2)	1.6(0.41)	3.8(0.61)	0.14(0.90)	-2.0(-1.2)	-0.03(-0.01)	4.20	4.16

\* indicates the correlation is statistically valid, based on the criteria of a 10% or less significance level corresponding to the t-statistic

<sup>27</sup> Table 4.4 uses the shorthand notation of the correlation coefficients. NUM – number of existing latrines owned by the participant household. MAIN – maintenance that the participants performed on their existing latrine (1 = yes they did maintenance, 2 = no maintenance). COST – the original cost of construction for the participant's existing latrine(s). PROP – the proportion of discretionary income allocated to investment in sanitation infrastructure. RANK – the rank of investment in sanitation infrastructure amongst 9 other possible infrastructure and livelihood investments. ECON – the total average economic score of the participant. REMIT – the reception of remittances (1 = yes, 0= no). EDUC – the educational level of the participant.

for t-statistics can be found in t-distribution tables found in most statistics textbooks. These tables show the significance level for a specific t-statistic with a certain number of degrees of freedom.

This thesis, used the t-distribution table provided in Montgomery (2001) to find the corresponding significance level using the tabulated t-statistics for each variable in each regression model and the degrees of freedom for each regression model. The coefficient of multiple determination ( $R^2$ ) is a measure of the fraction of the variability in the dependent variable that can be explained by the regression model. For example, with an  $R^2$  value of 10.3%, only 10.3% of the variability of the willingness-to-pay is explained by the overall regression model. Thus, the higher the value of  $R^2$ , the better the overall regression model explains the variability in willingness-to-pay. The F value tabulated in Tables 4.7 – 4.22 could also be used to determine the statistical validity of the overall regression model, using the F-distribution tables found in most statistics textbooks.

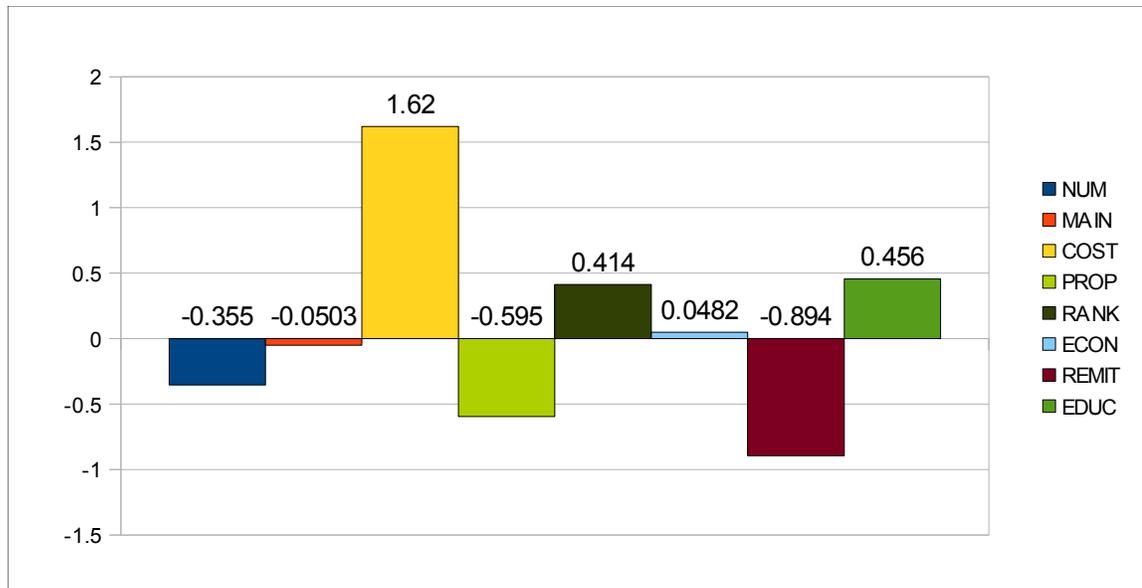
Table 4.7 shows the ordinary least squares modeling results for the willingness-to-pay data for a self-constructed cement slab that is meant to be an improvement to an existing latrine. This regression found a negative relation between willingness-to-pay and the number of latrines currently owned, improvements and maintenance previously performed on existing latrines, the proportion of disposable income allocated for latrines, and the reception of remittances. Positive correlations were found between the willingness-to-pay data and the original cost of current latrine(s), the rank of sanitation investment among other infrastructure and livelihood investments, the total average economic score, and education level. Only the correlations with original cost of current latrine(s) and reception of remittance satisfied the criteria for statistical validity for

individual regression variables, both reaching a significance level of 2.5% based on the t-statistic. The overall regression model only explained 10.3% ( $R^2$  value) of the variability in willingness-to-pay and did not reach the accepted minimum of 15% for statistical validity. Figure 4.1 graphically shows the strength of the correlation for each of the variables affecting willingness-to-pay for a self-constructed cement slab that is meant to be an improvement to an existing latrine.

Table 4.8 shows the results of the ordinary least squares modeling of the willingness-to-pay for lining the pit with cement bricks for stability and sealing the pit with cement to prevent contamination of shallow ground water. The only statistically valid correlations with willingness-to-pay were the negative correlation with improvements and maintenance previously performed on existing latrine(s) (10% significance), the positive correlation with original cost of construction of existing latrine(s) (2.5% significance), and the negative correlation with reception of remittances (5% significance). The  $R^2$  value of 10.4% signifies 10.4% of the variability in willingness-to-pay being explained by the overall regression model, and does not reach the minimum required 15% for model statistical validity. Figure 4.2 graphically shows the strength of the correlation between willingness-to-pay for sealing and lining the pit on an existing latrine and each of the regression variables.

**Table 4.7:** Ordinary least squares modeling of willingness-to-pay data for a self-constructed cement slab as an improvement to an existing latrine

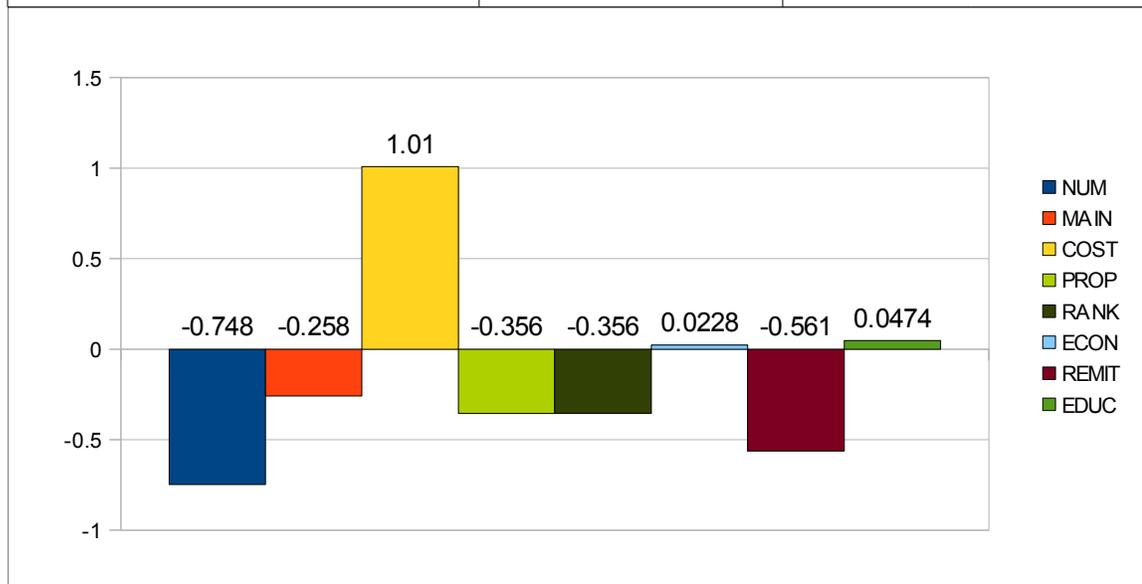
Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	11.9	3.18	0.25%
NUM	-0.355	-0.232	>40%
MAIN	-0.0503	-0.216	>40%
COST	1.62	2.15	2.5%
PROP	-0.595	-0.641	40%
RANK	0.414	0.272	40%
ECON	0.0482	1.28	25%
REMIT	-0.894	-2.13	2.5%
EDUC	0.456	0.577	40%
Statistics			
R <sup>2</sup>	10.30%		
Degrees of Freedom	86		
F-value	1.22		



**Figure 4.1:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for a self-constructed cement slab as an improvement to an existing latrine

**Table 4.8:** Ordinary least squares modeling of willingness-to-pay data for sealing and lining the pit with cement in an existing latrine

Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	13.9	5.29	0.05%
NUM	-0.748	-0.697	25%
MAIN	-0.258	-1.58	10%
COST	1.08	2.04	2.5%
PROP	-0.356	-0.548	40%
RANK	-0.356	-0.333	40%
ECON	0.0228	0.860	25%
REMIT	-0.561	-1.91	5%
EDUC	0.0474	0.0855	>40%
Statistics			
R <sup>2</sup>	10.40%		
Degrees of Freedom	86		
F-value	1.23		



**Figure 4.2:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for sealing and lining the pit with cement on an existing latrine

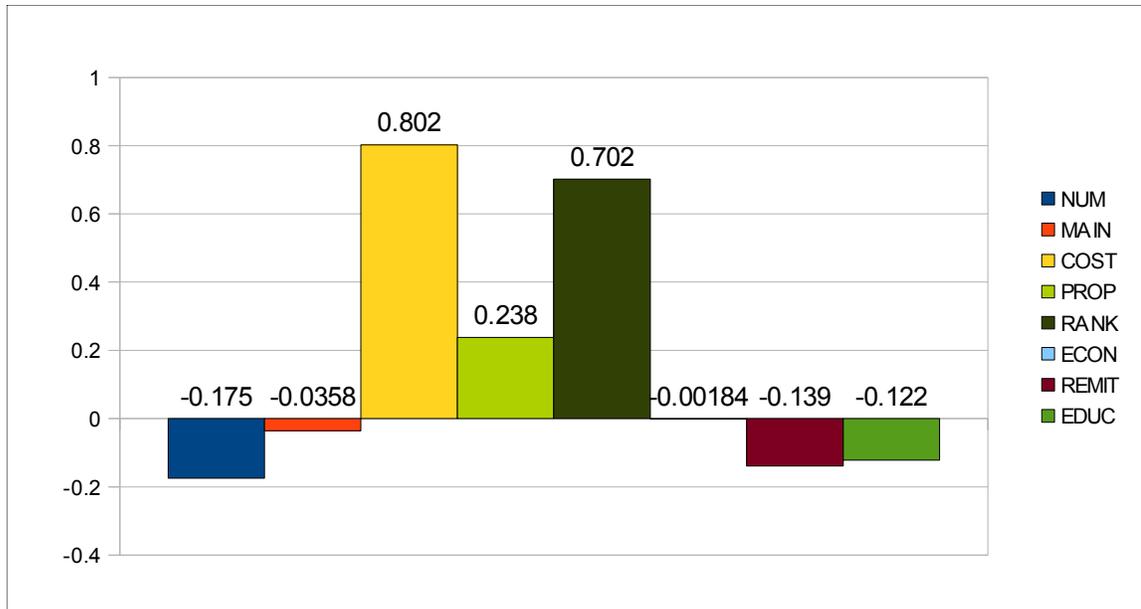
Table 4.9 shows the results of the ordinary least squares regression model of willingness-to-pay for adding a thatched roof to an existing latrine. Only the positive correlation between willingness-to-pay and the original cost of construction of existing

latrine(s) satisfied the criteria for statistical validity, with a 5% significance level. 5.28% of the variability in willingness-to-pay was explained by the overall regression model, not reaching the minimum required 15% for statistical validity. Figure 4.3 shows the strength of correlation for each of the variables in the regression model.

Table 4.10 shows the results of the ordinary least squares regression model of willingness-to-pay for adding a metal roof to an existing latrine. The only statistically valid correlation found was the positive correlation with the original cost of existing latrine(s), with a 2.5% significance level. Only 7.00% of the variability in willingness-to-pay was explained by the overall regression model, thus the minimum required 15% was not met and the overall regression model cannot be considered statistically valid. Figure 4.4 shows the strength of correlation between each regression variables and willingness-to-pay for adding a metal roof to an existing latrine.

**Table 4.9:** Ordinary least squares modeling of willingness-to-pay data for adding a thatched roof to an existing latrine

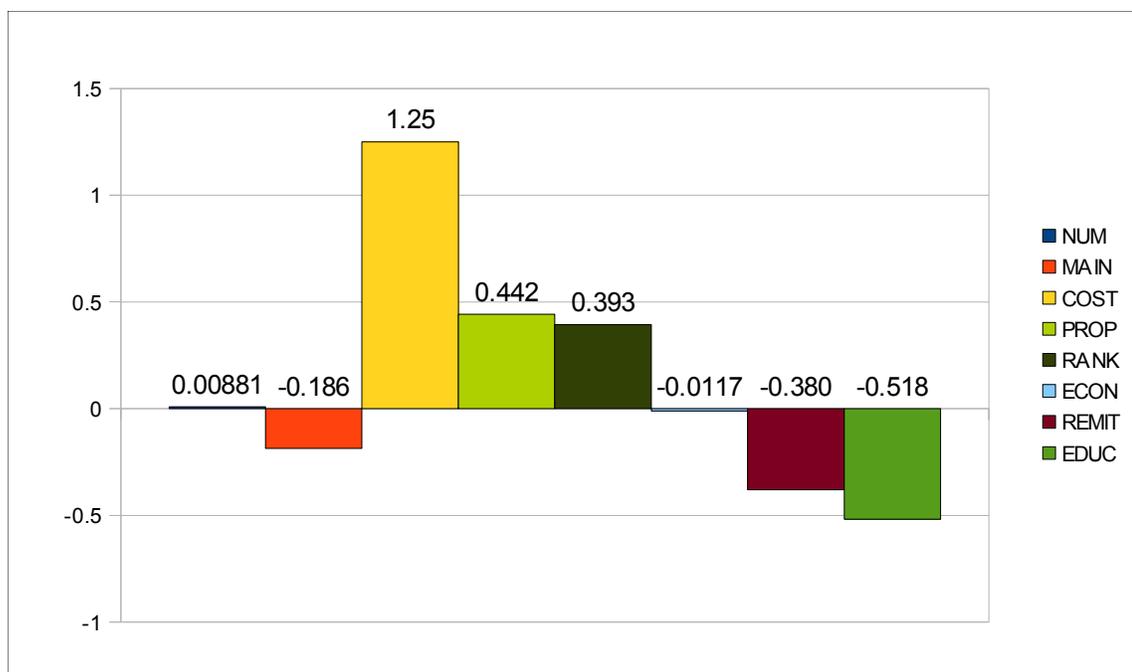
Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	2.41	1.15	25%
NUM	-0.175	-0.205	>40%
MAIN	-0.0358	-0.276	40%
COST	0.802	1.91	5%
PROP	0.238	0.461	40%
RANK	0.702	0.826	25%
ECON	-0.00184	-0.0879	>40%
REMIT	-0.139	-0.594	40%
EDUC	-0.122	-0.278	40%
Statistics			
R <sup>2</sup>	5.28%		
Degrees of Freedom	86		
F-value	0.592		



**Figure 4.3:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for adding a thatched roof to an existing latrine

**Table 4.10:** Ordinary least squares modeling of willingness-to-pay data for adding a metal roof to an existing latrine

Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	14.6	4.79	0.05%
NUM	0.00881	0.00707	>40%
MAIN	-0.186	-0.980	25%
COST	1.25	2.04	2.5%
PROP	0.442	0.586	40%
RANK	0.393	0.317	40%
ECON	-0.0117	-0.384	40%
REMIT	-0.380	-1.11	25%
EDUC	-0.518	-0.806	25%
Statistics			
R <sup>2</sup>	7.00%		
Degrees of Freedom	86		
F-value	0.799		



**Figure 4.4:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for adding a metal roof to an existing latrine

Table 4.11 shows the results of the ordinary least squares regression model of willingness-to-pay for installing a soak pit to promote infiltration of wash water on an existing latrine. The only statistically valid correlation with willingness-to-pay was the negative correlation with previously performed improvements and maintenance to existing latrines, with a 10% significance level. 7.39% of the variability in willingness-to-pay is explained by the overall regression model. This does not reach the required level of 15%, and thus the overall regression model cannot be considered statistically valid. Figure 4.5 shows the strength of correlation between willingness-to-pay and each of the regression variables.

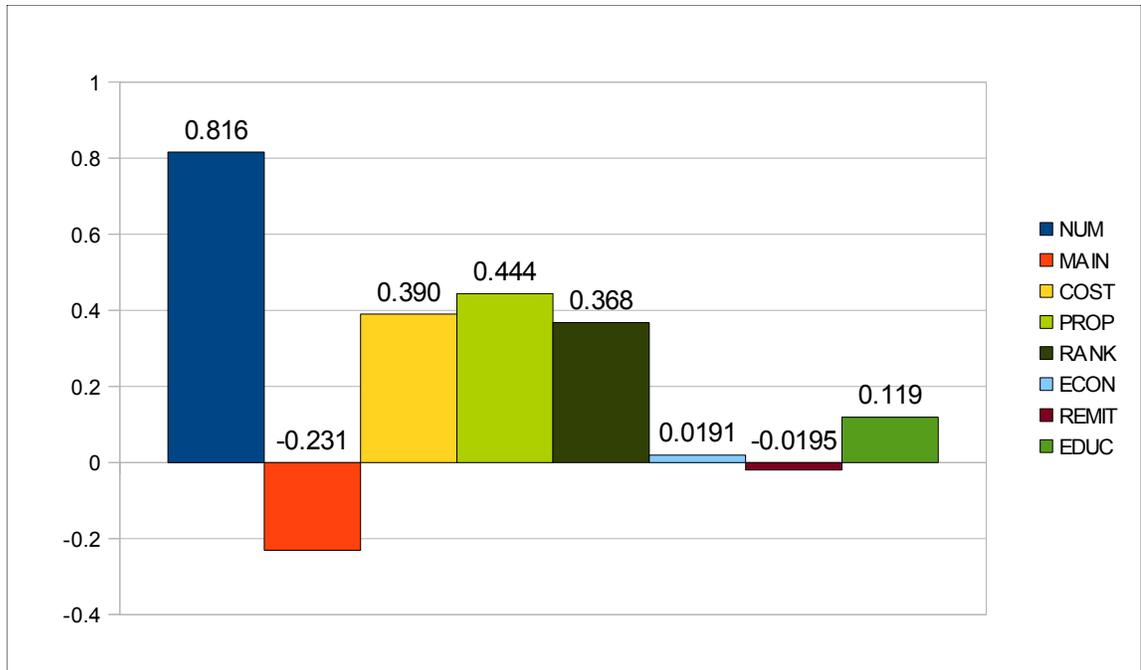
Table 4.12 shows the results of the ordinary least squares regression model of willingness-to-pay for purchasing a pre-manufactured cement slab as an improvement to an existing latrine or as a replacement of a broken slab on an existing latrine. None of the regression variables produced a statistically valid correlation with willingness-to-pay. The

overall regression model only explained 2.23% of the variability in willingness-to-pay, thus not reaching the required level to confirm statistical validity of the regression model. Figure 4.6 shows the strength of correlation between willingness-to-pay and each of the regression variables.

Table 4.13 shows the results of the ordinary least squares regression modeling of willingness-to-pay for building a cement privacy shelter on an existing latrine. As in the previous regression, none of the variables produced a statistically valid correlation to willingness-to-pay. The  $R^2$  value of 6.93% shows that only 6.93% of the variability in willingness-to-pay was explained by the overall regression model, thus the model cannot be considered statistically valid. Figure 4.7 shows the strength of correlation between willingness-to-pay and each of the regression variables.

**Table 4.11:** Ordinary least squares modeling of willingness-to-pay data for installing a soak pit on an existing latrine

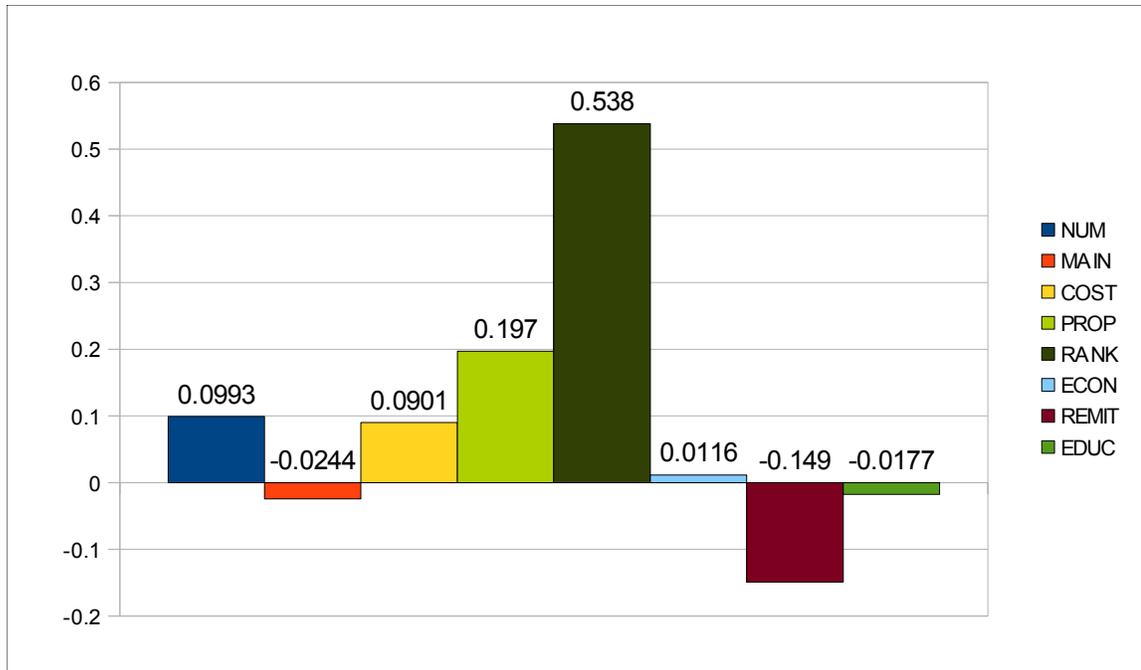
Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	9.66	4.07	0.05%
NUM	0.816	0.844	25%
MAIN	-0.231	-1.570	10%
COST	0.390	0.815	25%
PROP	0.444	0.758	25%
RANK	0.368	0.382	40%
ECON	0.0191	0.805	25%
REMIT	-0.0195	-0.0734	>40%
EDUC	0.119	0.238	>40%
Statistics			
$R^2$	7.39%		
Degrees of Freedom	86		
F-value	0.848		



**Figure 4.5:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for installing a soak pit on an existing latrine

**Table 4.12:** Ordinary least squares modeling of willingness-to-pay data for purchasing a pre-manufactured cement slab for installation on an existing latrine

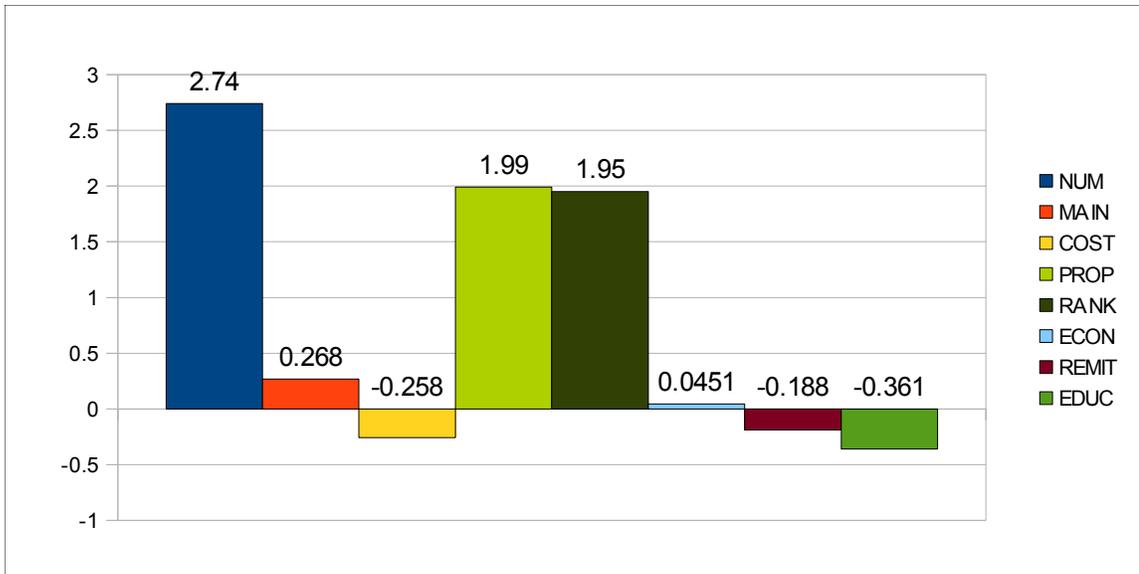
Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	12.0	6.23	0.05%
NUM	0.0993	0.126	>40%
MAIN	-0.0244	-0.203	>40%
COST	0.0901	0.232	>40%
PROP	0.197	0.413	40%
RANK	0.538	0.685	25%
ECON	0.0116	0.599	40%
REMIT	-0.149	-0.689	25%
EDUC	-0.0177	-0.0433	>40%
Statistics			
R <sup>2</sup>	2.23%		
Degrees of Freedom	86		
F-value	0.243		



**Figure 4.6:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for purchasing a pre-manufactured cement slab for installation on an existing latrine

**Table 4.13:** Ordinary least squares modeling of willingness-to-pay data for installing a cement privacy shelter on an existing latrine

Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	17.0	2.69	5%
NUM	2.74	1.07	25%
MAIN	0.268	0.686	25%
COST	-0.258	-0.204	>40%
PROP	1.99	1.28	25%
RANK	1.95	0.764	25%
ECON	0.0451	0.714	25%
REMIT	-0.188	-0.267	20%
EDUC	-0.361	-0.272	20%
Statistics			
R <sup>2</sup>	6.93%		
Degrees of Freedom	86		
F-value	0.791		



**Figure 4.7:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for installing a cement privacy shelter on an existing latrine

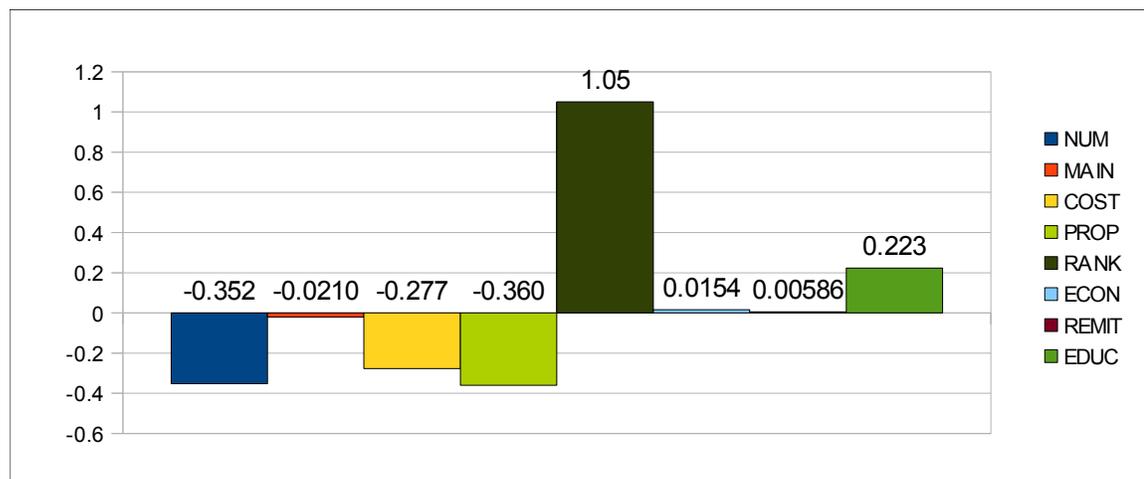
Table 4.14 contains the results of the ordinary least squares regression model for installing a ventilation pipe in an existing latrine. This model also failed to produce a statistically valid correlation between willingness-to-pay and any of the regression variables. The overall regression model cannot be considered statistically valid because the  $R^2$  value of 3.51% does not meet the minimum required 15%. Figure 4.8 shows the strength of correlation between willingness-to-pay and each of the regression variables, although it is important to note none of these correlations satisfy the criteria for statistical validity.

Table 4.15 shows the results of the ordinary least squares regression modeling of willingness-to-pay for maintenance of the pit of an existing latrine. Pit maintenance includes emptying the pit when full or filling in the pit, digging a new one, and rebuilding the latrine superstructure over the new pit. The only statistically valid correlation produced by this regression analysis is between willingness-to-pay and education level, with a 2.5% significance. The  $R^2$  value of 7.33% does not fulfill the

requirement of at least 15% for overall regression model statistical validity. Figure 4.9 shows the strength of correlation between willingness-to-pay and each of the regression variables, although it is important to note that only the correlation with education level achieved statistical validity.

**Table 4.14:** Ordinary least squares modeling of willingness-to-pay data for installing a ventilation pipe in an existing latrine

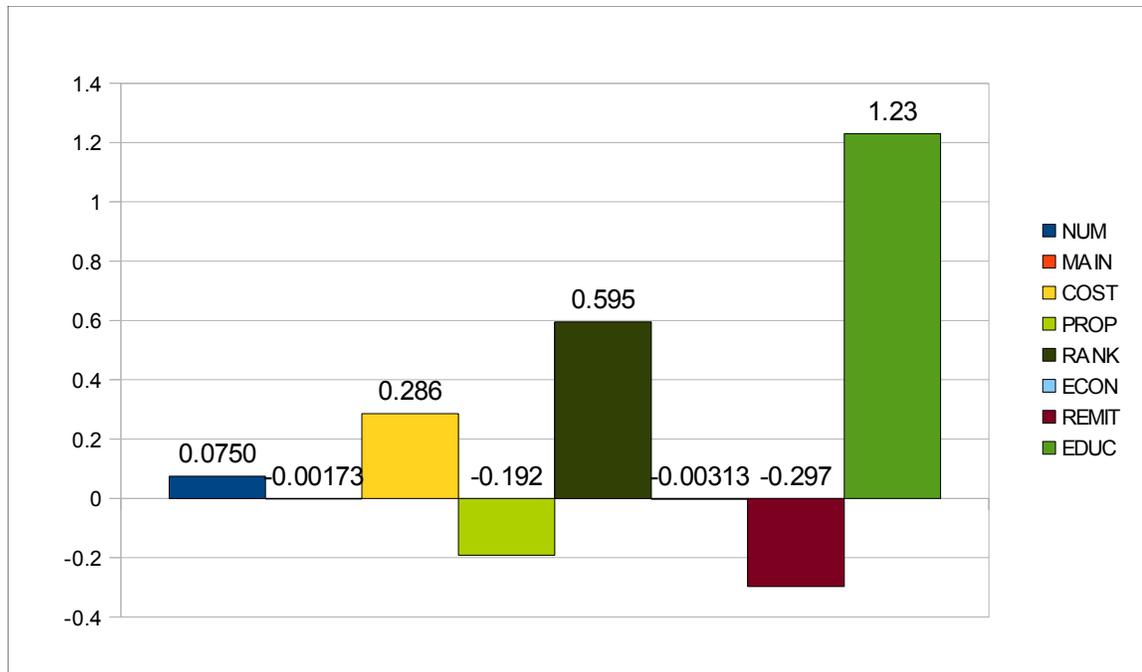
Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	6.45	3.22	0.25%
NUM	-0.352	-0.431	40%
MAIN	-0.0210	-0.169	>40%
COST	-0.277	-0.689	25%
PROP	-0.360	-0.729	25%
RANK	1.05	1.29	25%
ECON	0.0154	0.765	25%
REMIT	0.00586	0.0262	>40%
EDUC	0.223	0.529	40%
Statistics			
R <sup>2</sup>	3.51%		
Degrees of Freedom	86		
F-value	0.386		



**Figure 4.8:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for installing a ventilation pipe in an existing latrine

**Table 4.15:** Ordinary least squares modeling of willingness-to-pay data for emptying the pit or filling in the pit, digging new pit, and re-building an existing latrine

Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	8.52	3.29	0.10%
NUM	0.0750	0.0710	>40%
MAIN	-0.00173	-0.01080	>40%
COST	0.286	0.551	40%
PROP	-0.192	-0.300	40%
RANK	0.595	0.566	40%
ECON	-0.00313	-0.121	>40%
REMIT	-0.297	-1.03	25%
EDUC	1.23	2.25	2.5%
Statistics			
R <sup>2</sup>	7.33%		
Degrees of Freedom	86		
F-value	0.840		



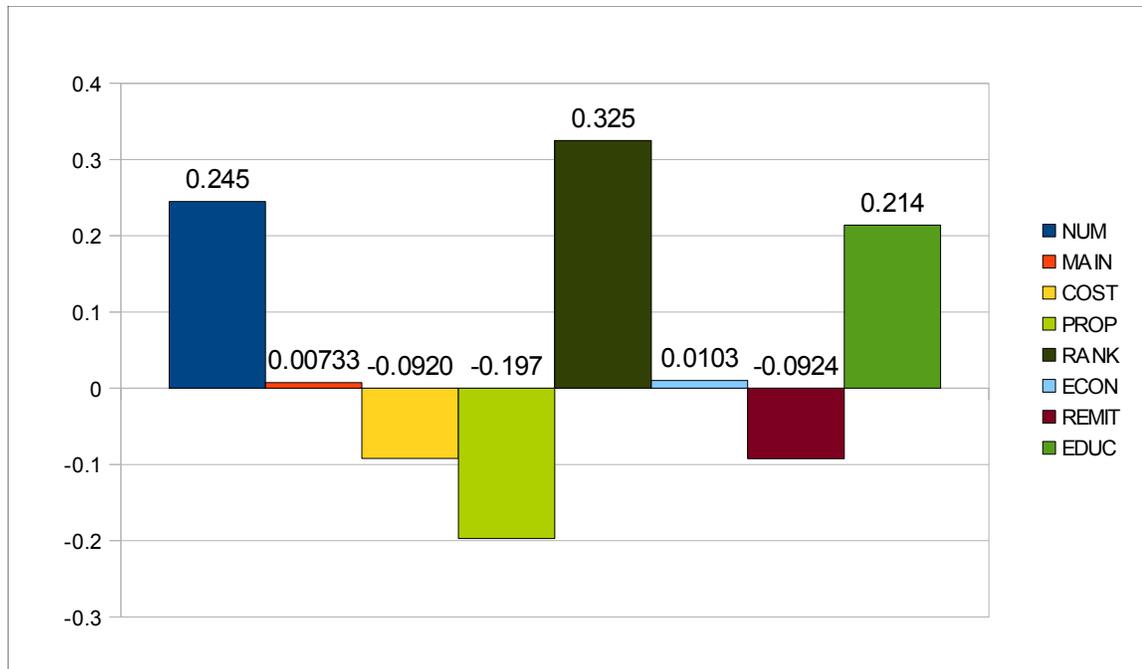
**Figure 4.9:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for emptying the pit and/or filling in the pit, digging new pit, and re-building an existing latrine

Table 4.16 shows the ordinary least square regression modeling result for willingness-to-pay data for soak pit maintenance, including cleaning the rocks and re-digging/expanding the pit in order to promote infiltration into the surrounding soil. Again, none of the regression variables produced a statistically valid correlation with willingness-to-pay, as they did not reach the required level of 10% significance. The  $R^2$  value of 3.37% shows that only 3.37% of the variability in willingness-to-pay was explained by the overall regression model. This value does not meet the accepted minimum requirement of 15% for statistical validity of the overall regression model. Figure 4.10 shows the strength of correlation between each of the regression variables and willingness-to-pay; however, none of these correlations have reached the required level of significance for statistical validity.

Table 4.17 shows the results of the ordinary least square regression modeling of willingness-to-pay for superstructure maintenance. Superstructure maintenance includes washing the walls and slab, fixing cracks in the walls and slab, replacing broken bricks in the walls, and replacing broken or missing roofing material. Only the positive correlation between willingness-to-pay and the stated rank of importance of investment in sanitation infrastructure met the requirement for statistical validity with a 10% significance level. 5.56% of the variability in willingness-to-pay could be explained by the overall regression model, and this did not reach the required level of 15% for statistical validity of the overall regression model. Figure 4.11 shows the strength of correlation between the regression variables and willingness-to-pay for superstructure maintenance, although it is important to note that only the correlation for stated rank of importance of investment in sanitation infrastructure was statistically valid.

**Table 4.16:** Ordinary least squares modeling of willingness-to-pay data for soak pit maintenance on an existing latrine

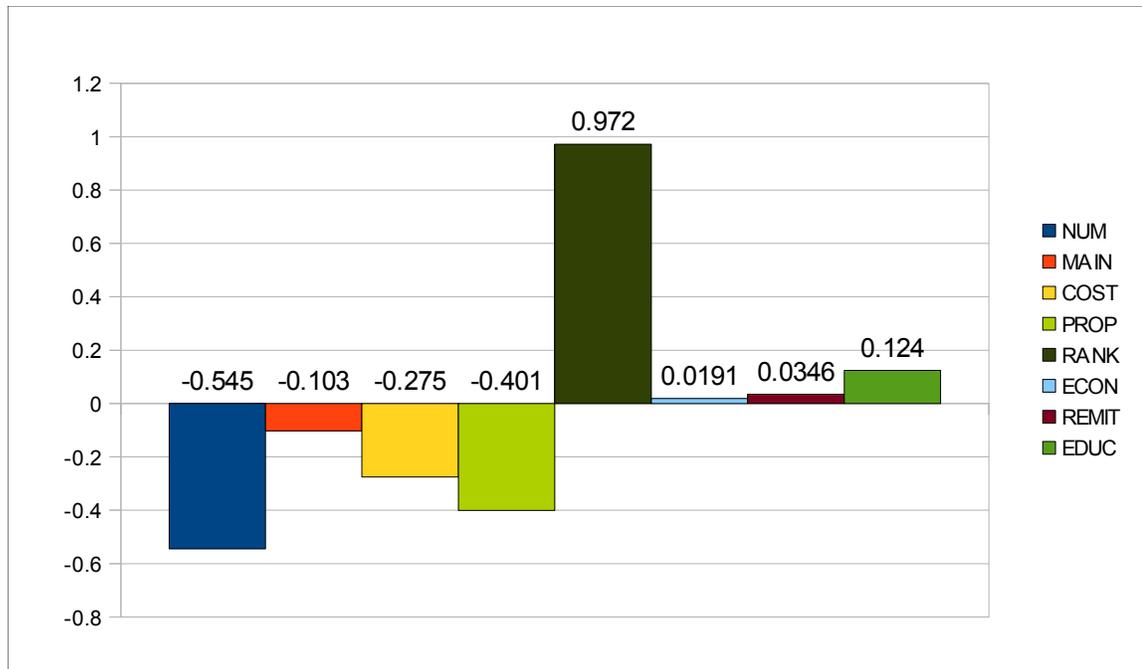
Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	4.39	3.65	0.05%
NUM	0.245	0.499	25%
MAIN	0.00733	0.0982	>40%
COST	-0.0920	-0.381	40%
PROP	-0.197	-0.662	40%
RANK	0.325	0.665	40%
ECON	0.0103	0.857	25%
REMIT	-0.0924	-0.687	25%
EDUC	0.214	0.848	25%
Statistics			
R <sup>2</sup>	3.37%		
Degrees of Freedom	86		
F-value	0.371		



**Figure 4.10:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for soak pit maintenance on an existing latrine

**Table 4.17:** Ordinary least squares modeling of willingness-to-pay data for superstructure maintenance on an existing latrine

Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	6.53	3.71	0.05%
NUM	-0.545	-0.759	25%
MAIN	-0.103	-0.948	25%
COST	-0.275	-0.778	25%
PROP	-0.401	-0.924	25%
RANK	0.972	1.360	10%
ECON	0.0191	1.080	25%
REMIT	0.0346	0.176	>40%
EDUC	0.124	0.336	40%
Statistics			
R <sup>2</sup>	5.56%		
Degrees of Freedom	86		
F-value	0.625		



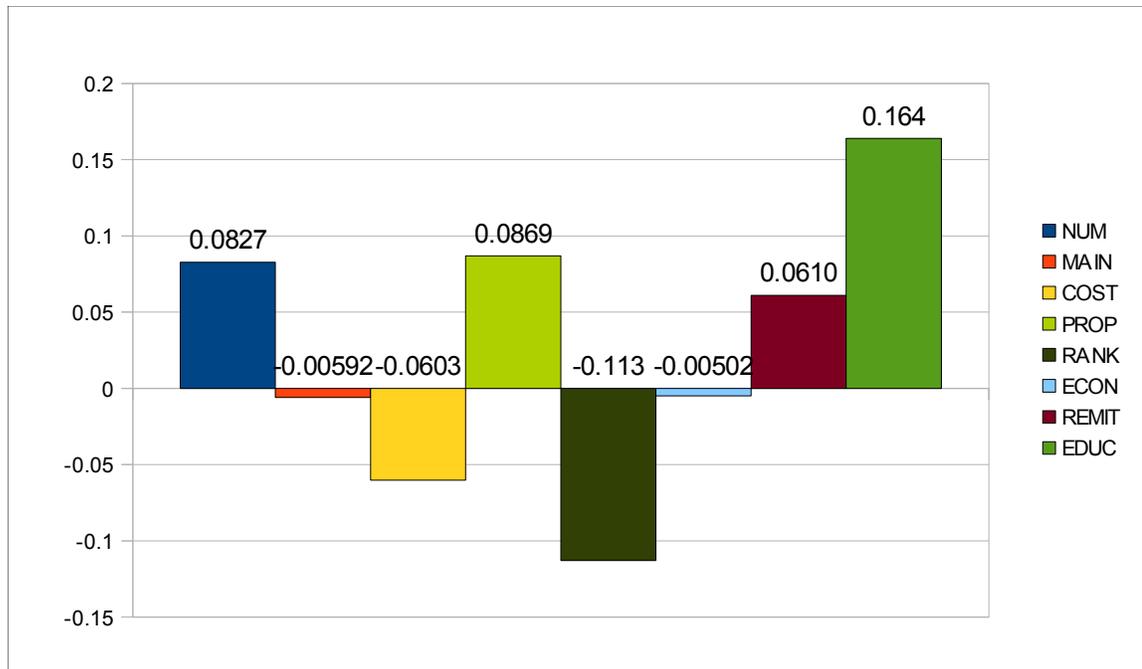
**Figure 4.11:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for superstructure maintenance on an existing latrine

Table 4.18 shows the results of the ordinary least squares regression modeling of willingness-to-pay for purchasing a month's supply of soap for hand-washing. None of the regression variables produces a statistically valid correlation, as they all had more than 10% significance. The  $R^2$  value of 3.15% did not reach the required minimum of 15% for statistical validity of the overall regression model. Figure 4.12 shows the strength of correlation between willingness-to-pay and each of the regression variables, although none of them satisfy the requirements of statistical validity.

Table 4.19 shows the results of the ordinary least squares regression modeling of willingness-to-pay for a ventilated improved pit (VIP) latrine with a thatched roof and a pre-manufactured cement slab. This willingness-to-pay is a composite obtained by summing the willingness-to-pay maximum values for each of the latrine components of a VIP latrine of this nature (i.e. pre-manufactured cement slab, thatched roof, cement privacy shelter, ventilation pipe, soak pit, and lined and sealed with cement defecation pit). The significance level was consistently above the accepted 10%, and thus none of the regression variables produced a statistically valid correlation with willingness-to-pay data, 3.89% of the variability in the willingness-to-pay data could be explained by the overall regression model, and thus the overall regression model can be considered statistically invalid as it does not meet the minimum required 15%. Figure 4.13 graphically shows the strength of correlation of willingness-to-pay data and each of the regression variables.

**Table 4.18:** Ordinary least squares modeling of willingness-to-pay data for monthly purchasing soap for hand-washing

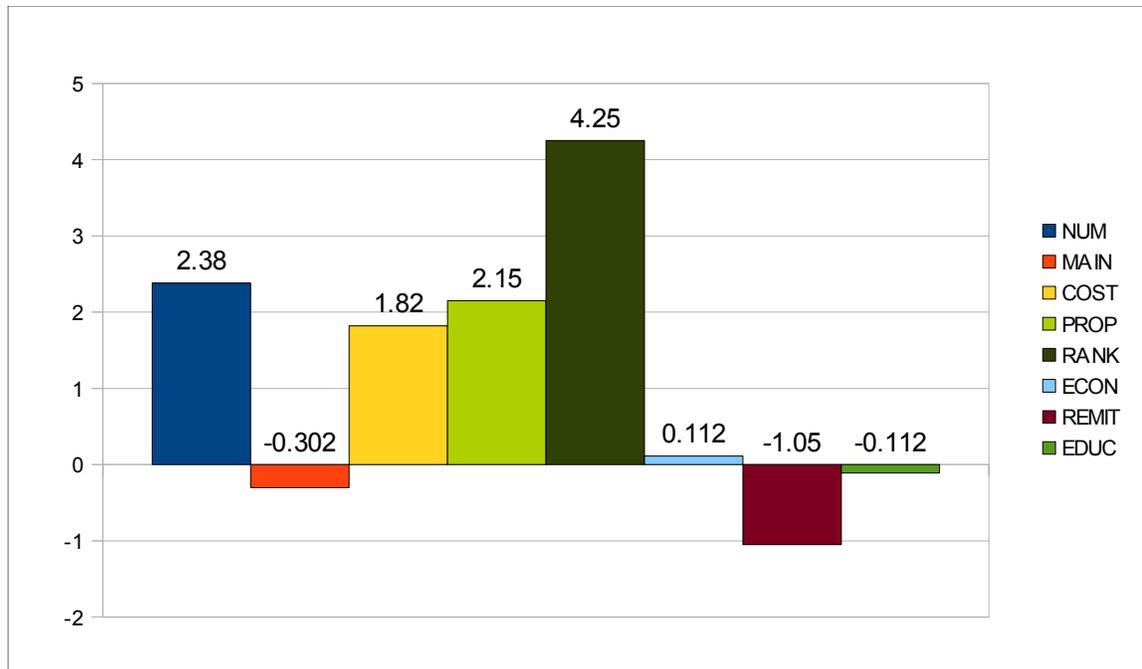
Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	3.86	4.61	0.05%
NUM	0.0827	0.242	>40%
MAIN	-0.00592	-0.114	>40%
COST	-0.0603	-0.358	40%
PROP	0.0869	0.420	40%
RANK	-0.113	-0.332	40%
ECON	-0.00502	-0.597	40%
REMIT	0.0610	0.651	40%
EDUC	0.164	0.931	25%
Statistics			
R <sup>2</sup>	3.15%		
Degrees of Freedom	86		
F-value	0.35		



**Figure 4.12:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for monthly purchasing soap for hand-washing

**Table 4.19:** Ordinary least squares modeling of willingness-to-pay data for a ventilated improved pit latrine with a thatched roof and pre-manufactured cement slab

Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	61.4	4.39	0.05%
NUM	2.38	0.417	40%
MAIN	-0.302	-0.348	40%
COST	1.82	0.649	40%
PROP	2.15	0.622	40%
RANK	4.25	0.749	25%
ECON	0.112	0.800	25%
REMIT	-1.05	-0.672	40%
EDUC	-0.112	-0.0380	>40%
Statistics			
R <sup>2</sup>	3.89%		
Degrees of Freedom	86		
F-value	0.430		



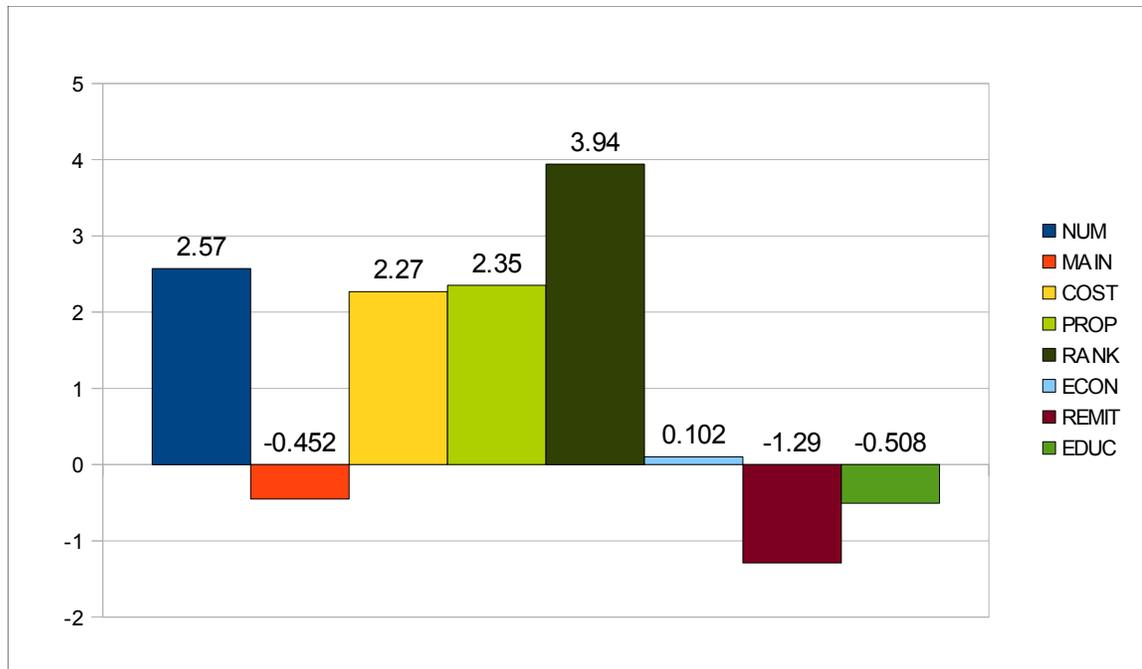
**Figure 4.13:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for a ventilated improved pit latrine with a thatched roof and a pre-manufactured cement slab

Table 4.20 shows the results of the ordinary least squares regression modeling of willingness-to-pay for a ventilated improved pit (VIP) latrine with a metal roof and a pre-manufactured cement slab. This willingness-to-pay is a composite obtained by summing the willingness-to-pay maximum values for each of the latrine components of a VIP latrine of this nature (i.e. pre-manufactured cement slab, metal roof, cement privacy shelter, ventilation pipe, soak pit, and lined and sealed with cement defecation pit). None of the regression variables reached the accepted level of 10% significance for statistical validity. 4.11% of the variability in the willingness-to-pay data could be explained by the overall regression model, and thus the overall regression model can be considered statistically invalid as it does not meet the minimum required 15%. Figure 4.14 shows the strength of correlation of willingness-to-pay data and each of the regression variables.

Table 4.21 shows the results of the ordinary least squares regression modeling of willingness-to-pay for a ventilated improved pit (VIP) latrine with a thatched roof and a self-constructed cement slab. This willingness-to-pay is a composite obtained by summing the willingness-to-pay maximum values for each of the latrine components of a VIP latrine of this nature (i.e. self-constructed cement slab, thatched roof, cement privacy shelter, ventilation pipe, soak pit, and lined and sealed with cement defecation pit). None of the regression variables reached the accepted level of 10% significance for statistical validity. 4.11% of the variability in the willingness-to-pay data could be explained by the overall regression model, and thus the overall regression model can be considered statistically invalid as it does not meet the minimum required 15%. Figure 4.15 shows the strength of correlation of willingness-to-pay data and each of the regression variables.

**Table 4.20:** Ordinary least squares modeling of willingness-to-pay data for a ventilated improved pit latrine with a metal roof and pre-manufactured cement slab

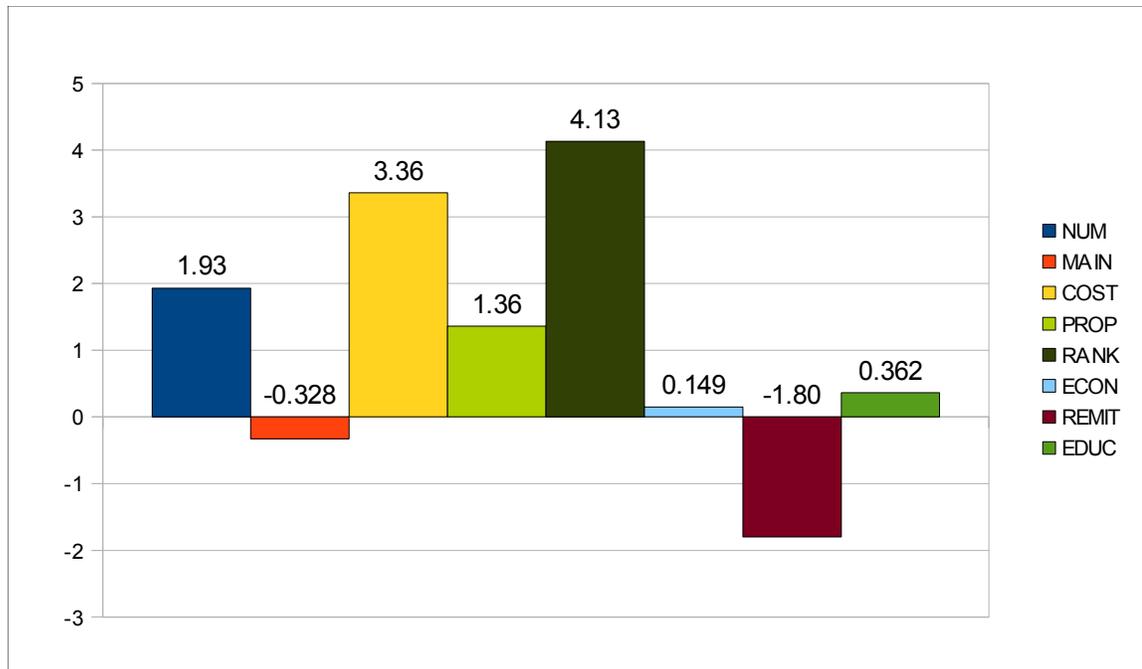
Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	73.7	5.14	0.05%
NUM	2.57	0.439	40%
MAIN	-0.452	-0.508	40%
COST	2.27	0.789	25%
PROP	2.35	0.665	40%
RANK	3.94	0.678	25%
ECON	0.102	0.711	25%
REMIT	-1.29	-0.805	25%
EDUC	-0.508	-0.1680	>40%
Statistics			
R <sup>2</sup>	4.11%		
Degrees of Freedom	86		
F-value	0.456		



**Figure 4.14:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for a ventilated improved pit latrine with a metal roof and a pre-manufactured cement slab

**Table 4.21:** Ordinary least squares modeling of willingness-to-pay data for a ventilated improved pit latrine with a thatched roof and self-constructed cement slab

Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	61.3	4.08	0.05%
NUM	1.93	0.314	40%
MAIN	-0.328	-0.352	40%
COST	3.36	1.11	25%
PROP	1.36	0.365	40%
RANK	4.13	0.676	40%
ECON	0.149	0.986	25%
REMIT	-1.80	-1.07	25%
EDUC	0.362	0.114	>40%
Statistics			
R <sup>2</sup>	4.11%		
Degrees of Freedom	86		
F-value	0.456		

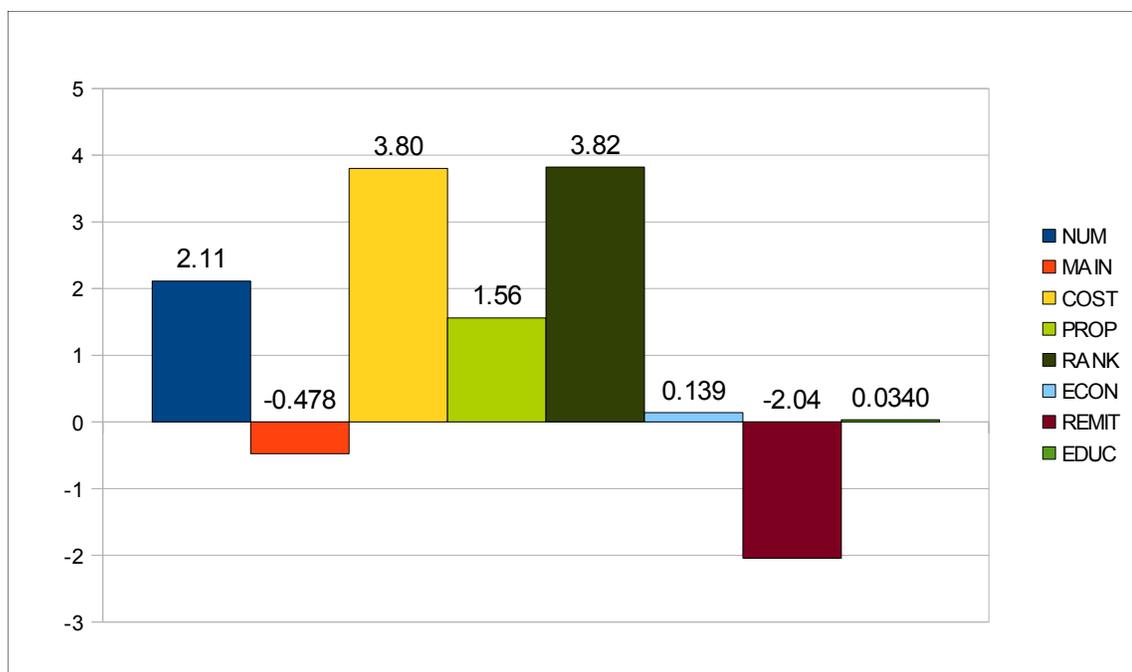


**Figure 4.15:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for a ventilated improved pit latrine with a thatched roof and a self-constructed cement slab

Table 4.22 shows the results of the ordinary least squares regression modeling of willingness-to-pay for a ventilated improved pit (VIP) latrine with a metal roof and a self-constructed cement slab. This willingness-to-pay is a composite obtained by summing the willingness-to-pay maximum values for each of the latrine components of a VIP latrine of this nature (i.e. self-constructed cement slab, metal roof, cement privacy shelter, ventilation pipe, soak pit, and lined and sealed with cement defecation pit). None of the regression variables reached the accepted level of 10% significance for statistical validity. 5.13% of the variability in the willingness-to-pay data could be explained by the overall regression model, and thus the overall regression model can be considered statistically invalid as it does not meet the minimum required 15%. Figure 4.16 shows the strength of correlation of willingness-to-pay data and each of the regression variables.

**Table 4.22:** Ordinary least squares modeling of willingness-to-pay data for a ventilated improved pit latrine with a metal roof and self-constructed cement slab

Variable	Correlation Coefficient	t-Statistic	Significance Level
Intercept	73.6	4.76	0.05%
NUM	2.11	0.335	40%
MAIN	-0.478	-0.499	40%
COST	3.80	1.23	25%
PROP	1.56	0.409	40%
RANK	3.82	0.609	40%
ECON	0.139	0.896	25%
REMIT	-2.04	-1.18	25%
EDUC	0.0340	-0.0105	>40%
Statistics			
R <sup>2</sup>	5.13%		
Degrees of Freedom	86		
F-value	0.575		



**Figure 4.16:** Bar graph of correlation coefficients for ordinary least squares regression on willingness-to-pay data for a ventilated improved pit latrine with a metal roof and a self-constructed cement slab

#### 4.4: Summary of Qualitative Sanitation Infrastructure Importance Data

The willingness-to-pay data and regression of the results was only a part of the assessment of the importance of sanitation infrastructure in the daily lives of people in open defecation free (ODF) villages in Mopti, Mali. Section 4 of the questionnaire (see Appendix A for details) also collected data to assess the proportion of discretionary income that participants typically allocated to sanitation infrastructure, the everyday purchases that participants would be willing to forgo in order to rebuild a collapsed latrine, and the relative importance of sanitation infrastructure when compared to other planned infrastructure and livelihood investments.

The first question of this section, question 4-1, looked at the categories of products on which participants typically spent discretionary income. This question was developed with the Malian cultural context in mind. Abstract concepts such as

discretionary income, budgeting, and allocation of funds are not commonly understood and used in Mali, thus this question had to be formed in a way to be easily understood by the participants as well as produce meaningful responses. Instead of asking directly the proportion of discretionary funds that went to each category, the participants were asked to allocate 20 beans throughout the 8 categories, thus giving the proportion. The 8 categories were chosen based on the author and study partners knowledge of common purchases and were each comparable in price (i.e. buying tea and sugar once a day for a month is approximately the same price as buying meat for the family to eat once a day for 2 weeks). The wording of question 4-1 and the results are found in Table 4.23. The results of this question showed that the average participant allocated most of their

**Table 4.23:** Allocation of discretionary income on a monthly basis. Question shown with average responses reported in number of beans (% out of 20 beans). The results show the investment in sanitation infrastructure was ranked as the fourth highest priority for use of discretionary funds.

Q4-1 These beans represent your money. After buying enough food to feed your family this month, you have twenty (20) beans left. Do you spend these beans on (indicate how many beans go to each category):

Saving to buy seeds for next growing season:	4.01 (20.1%)	Saving to buy another sheep/goat/cow:	2.76 (13.8%)
Saving to repair/improve your latrine:	2.57 (12.9%)	Buying soap for hand washing and bleach for six months:	2.04 (10.2%)
Buying tea and sugar once a day for a month:	1.85 (9.3%)	Buying new clothes for your children:	2.04 (10.2%)
Buying better food in market:	2.82 (14.1%)	Buying meat for your family to eat once a day for two weeks:	1.94 (9.7%)

discretionary funds (20.1%) to the investment in seeds for planting in the next growing season. Investment in sanitation infrastructure was the fourth highest average, winning 12.9% of discretionary funds on the average. Purchasing soap for hand-washing was

virtually tied with buying new clothes for the children in the family both getting allocated 10.2% of discretionary funds on the average.

For question 4-2 of the questionnaire, a list of ten necessities was developed by the author of this thesis and study partners, and the participants were asked to rank five of these ten in order of what items they were mostly likely to give up to pay for reconstruction of a collapsed latrine. The “pair-wise ranking” method was used for this question, the participants first selecting the top five things they would give up and then ranking those top five from the most likely to be given up (1) to the least likely (5).

The wording of the question and results can be found in Table 4.24. Drinking tea is a very important part of Malian culture, with most every gathering of two or three people who are visiting involving drinking tea. However, participants were most willing to give up purchasing tea and sugar in order to save money for the reconstruction of a collapsed latrine, with it being unranked (not in the top five items to be given up) by only 9 participants and having a geometric mean rank of 1.41 when ranked at all. The geometric mean is reported because it takes into account the sample size (i.e. the number of times ranked) as the standard mean would not be comparable across different sample sizes (i.e. different number of times ranked). It is important to note that buying meat and rice for the family to eat is not necessarily the norm, as the participants in this study were predominately subsistence farmers, mainly eating the crops that their family produces. It is interesting to note that purchasing soap for hand washing was the item with the second lowest geometric mean, indicating that it is the second most likely purchase to be given up to save money. This is troubling, but not surprising with only about 60% of the participants reporting that they use soap for hand-washing.

**Table 4.24:** Ranking of foregone purchases in order to re-build a collapsed latrine. Reported in both geometric mean and number of times unranked in ( )

Q4-2 Your latrine has fallen down. Which of these essentials do you forgo in order to build a new latrine (first have the participants identify the top 5 easiest things to go without and then use “pair-wise ranking” to rank these 5 in order of ease of going without, number 1 – 5)

Tea and sugar twice a day for two weeks:	1.41 (9)	Meat for dinner everyday for two weeks:	2.65 (33)
Three yards of fabric for a wedding in village:	2.42 (13)	New clothes for your children:	3.70 (59)
Soap for hand washing and bleach for six months:	2.20 (62)	Gas for your motorcycle for two months:	2.78 (36)
Building a new granary:	3.68 (44)	Building a new shade hanger:	3.29 (38)
Feeding your family rice for two weeks:	3.73 (75)	Taking your child to the hospital when he/she gets sick:	3.35 (69)

Question 4-3 of the questionnaire had participants directly rank the importance of making specific infrastructure and livelihood investments. The participants were provided a list of ten possible investments and asked to select the top five that they would want, and then these top five choices were ranked using the “pair-wise ranking” technique. The wording and results of question 4-3 can be found in Table 4.25. Investment in sanitation infrastructure on average was not very highly ranked coming in 7 of the possible 10 with a geometric mean of 3.62 and being unranked 39 times (out of the total sample of 94 respondents<sup>28</sup>). This suggests that future investment in sanitation infrastructure is not very important to the participants in this research study. A possible reason for this could be because this study was performed too close to the certification of a community as ODF; thus, at a time when the initial investment in sanitation infrastructure was still fresh in the minds of the participants. Their initial investment was

<sup>28</sup> 94 out of 95 participants in this research study completed the fourth section of the questionnaire.

still providing the initial sanitation service and except in a few cases additional investment was not seen as necessary because their original latrines were still functional.

**Table 4.25:** Ranking of the importance of investment in sanitation infrastructure as compared to other infrastructure and livelihood investments. Reported in geometric mean and number of times unranked in ( ). Investment in sanitation infrastructure ranked 7 out of the possible 10.

Q4-3 If you had enough money to buy all ten (10) of these items, which would you buy first. Put the following things in order of what you would buy (first have the participants identify the first 5 things they will purchase and then use “pair-wise ranking to number 1 – 5).

Bigger house:	2.35 (28)	A new motorcycle:	4.67 (76)
More fields:	1.62 (10)	Build a garden:	3.04 (66)
A private hand pump in your compound:	2.38 (31)	The best latrine/toilet in village:	3.62 (39)
More livestock to raise and sell or eat:	3.34 (66)	Working cows and plows for your fields:	2.24 (22)
Solar panel, battery, and television:	4.25 (87)	Horses and cart to take people to and from market:	3.98 (45)

## **Chapter 5: Conclusions and Recommendations for Further Research**

### 5.1: Fulfilling Research Objectives

The stated objectives of this research study were:

- Assess the current state of water, sanitation, and hygiene behaviors and infrastructure in open defecation free villages in Mopti, Mali.
- Assess the continuation/non-continuation of the behavior change brought about by Community-Led Total Sanitation (CLTS) in these villages.
- Look for possible correlations between willingness-to-pay data and certain socioeconomic characteristics, and make these data and correlations available to study partners to assist in beginning a Sanitation Marketing campaign in Mopti.

Although none of the regression models explained sufficient amounts of variability in willingness-to-pay and only a few of the correlations met the requirements to be considered statistically valid, the objectives of this research study were still met.

It is important to remember that the majority of residents of these villages were practicing open defecation as little as three years ago. At the time of the study, there were only 2 participants (2.1%) that reported some members of their family still practiced open defecation. The study team's village guides were quite distraught by this. They told the offending participants that they were putting the entire village in danger and that they needed to work to stop their family members that were open defecating. This shows that

the community-wide revulsion against open defecation and corresponding behaviors were sustained, thus indicating that CLTS was successful in facilitating real change.

More evidence of the CLTS process facilitating real change in the study villages can be found within the questionnaire data itself. For example, the participants reported the sustained use of 186 latrines throughout the study area. When a respondent reported that they currently did not own a latrine ( $n = 4$ ), they also reported that their latrine had recently collapsed from the rains, that they were planning to rebuild after harvest, and that they were using a neighbor's latrine in the mean time. 82.3% of the latrines that the study team found were in good condition.<sup>29</sup> Only 15 latrines (8.06%) were found throughout the study area that did not have covers for the defecation hole, indicating that stopping the spread of flies was understood to be an integral part of the design and operation of latrines. A majority of the participants ( $n = 61$ , 64.2%) reported that they had previously improved and/or performed maintenance on their latrine(s), the average cost of these improvements and maintenance being about 720f CFA, or approximately US \$1.54.<sup>30</sup> When asked why they had not continued improving their latrine(s), most of participants ( $n = 79$ , 83.2%) indicated that they either did not have enough money for more improvements or more improvements were not needed. A few ( $n = 12$  or 12.6%) reported that they were continuously improving their latrine(s) or they were saving to make future improvements.

Participants were also asked about the proportion of discretionary income they allocate to different types of investments and common purchases. The average response

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<sup>29</sup> Good condition was defined as having a slab that is sufficient to separate people from contact with excreta, provided with some mechanism to stop the spread of flies (e.g., covered defecation hole or ventilation), as well as a superstructure that will provide sufficient privacy. This is consistent with the Malian governmental definition of basic sanitation, as laid out by National Directorate of Sanitation and Pollution Control (DNACPN) representatives at the AfriSan3 Conference in Kigali, Rwanda, July 2011.

<sup>30</sup> At the time of the study, the exchange rate was 469f CFA to the US \$.

was that 12.9% of these funds were typically allocated to investment in sanitation infrastructure. This investment made sanitation infrastructure the fourth ranked of the categories of discretionary spending used, behind savings for the purchase of seed for the next growing season, purchasing better food for the family from market, and investment in livestock.

Participants were also asked to rank the importance of 10 different infrastructure and livelihood investments. The top 5 were chosen and ranked, leaving the bottom 5 unranked. Investment in sanitation infrastructure was left unranked (in the bottom 5) 39 times, representing 41.4% of the entire sample of all 6 villages. When sanitation infrastructure was ranked the geometric mean was 3.62. The geometric mean is reported because it can be used to compare data with different sample sizes.<sup>31</sup> Overall, a geometric mean of 3.62 placed sanitation infrastructure behind investment in farming fields, investment in working livestock (e.g. plow oxen), investment in housing, investment in alternative drinking water sources, investment in gardens, and investment in livestock (e.g., sheep, goats). Because the participants were first told to select 5 from the list of 10 investments, it was easy to put latrines in that group in an apparent effort to appease the study team. However, once the participants gave the ranking sufficient thought, they often ranked investment in sanitation infrastructure low among the top 5 investments. Thus, investment in sanitation infrastructure was ranked most of the time (59.6%), but not ranked very highly (geometric mean 3.62 out of 5).

The results from the question concerning the barriers to stopping open defecation shows the effectiveness of CLTS interventions as well. Fifty-seven participants (60.6%)

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<sup>31</sup> The sample size was different in each case because the specific choice could be left unranked, in the bottom 5, and only the times ranked would be included in the sample size for calculating the geometric mean.

reported people not knowing the dangers of open defecation being a reason that they do not have or use latrines. This was by far the most popular response, showing that coming to the realization of the dangers of open defecation helps to create demand for sanitation infrastructure, in the rural Malian cultural context. The second and third most popular responses were closely related, that people are resistant to changing common behaviors (44.7% reporting) and that people do not think they need latrines (35.1% reporting). This is the main focus of CLTS, getting people to come to the realization of the dangers of open defecation, facilitating sanitation and hygiene behavior change, and correspondingly creating real demand for sanitation infrastructure.

The questionnaire data collected clearly showed the importance of sanitation infrastructure in the daily lives of the participants. Future investment in sanitation infrastructure was not very highly ranked, possibly because the initial investment in the participants latrine was believed to be sufficient, the latrines for the most part were functional. However, the data did show that in the 6 study villages the behavior change that was brought about by the CLTS intervention was sustained. The participants also showed evidence that they were improving and maintaining their latrines. This research study was successful in evaluating the CLTS intervention and the importance of sanitation infrastructure in the study villages

## 5.2: Willingness-to-Pay Regression Discussion

The questionnaire instrument was designed to minimize certain biases; however, in doing so the responses may have actually ended up being biased in different ways. Strategic bias happens when a participant responds in such a way that misrepresents their true willingness-to-pay in order to advantageously affect the eventual price of the product

or service in question. Strategic bias has been well documented as having an effect in contingent valuation (willingness-to-pay) studies in both the developed and developing world (Whittington, et al., 1993; Whittington, 1998; Onwujekwe, 2004; Venkatachalam, 2004; Carson & Hanemann, 2005; Cho, et al., 2005). The questionnaire was specifically designed to avoid this bias. By making it clear that this research study was for academic purposes only, and that the responses would not affect the policies of any of the study partners, US Peace Corps, UNICEF, and Regional Directorate of Sanitation and Pollution Control (DRACPN). The opening statement that was prepared to inform participants in this area is consistent with accepted willingness-to-pay study procedure (e.g. Whittington, et al., 1993). By making this fact clear to the participants, the study team hoped to mitigate the occurrence of strategic bias; however, this statement may have increased the incidence of hypothetical bias as a side effect.

Hypothetical bias can occur when the participants do not understand the importance of willingness-to-pay questions and simply answer without giving the question sufficient thought. The respondents will simply give the first answer that comes to mind and not worry that it does not reflect their true willingness-to-pay. A review of literature showed that when this bias is prevalent, the data is randomly distributed and often does not show any correlation to the variables that according to economic theory affect willingness-to-pay (Whittington, et al., 1993, Venkatachalam, 2002; Carson & Hanemann, 2005; Gunatilake, et al., 2006).

This was precisely the case with the regression analysis of the willingness-to-pay data in this research study. For example, economy theory indicates that the participants economic status will be positively related to their willingness to pay

(Venkatachalam,2002; Carson & Hanemann, 2005). It stands to reason that the more money one has the more they will be willing to pay for an improved product or service or rather the more likely they are to purchase an improved product or service. However, as can be seen in Table 5.1, the correlations between willingness-to-pay and the participant's

**Table 5.1:** Correlation coefficients between total average economics score and each latrine construction or maintenance component for which willingness-to-pay was measured

Latrine Construction or Maintenance Component	Correlation Coefficient with Total Average Economics Score
Self-constructed cement slab as an improvement to an existing latrine	0.0482
Sealing and lining the pit with cement on an existing latrine	0.0228
Adding a thatched roof to an existing latrine	-0.00184
Adding a metal roof to an existing latrine	-0.0117
Installing a soak pit on an existing latrine	0.0191
Purchasing a pre-manufactured cement slab as an improvement to an existing latrine	0.0116
Building a cement privacy shelter for an existing latrine	0.0451
Installing a ventilation pipe on an existing latrine	0.0154
Pit maintenance including emptying the pit	-0.00313
Soak pit maintenance including re-digging/expanding the pit to allow for better infiltration into surrounding soil	0.0103
Superstructure maintenance including fixing cracks and replacing broke bricks in walls	0.0191
Purchasing a month's supply of soap for hand-washing	-0.00502
Building a new VIP latrine with a thatched roof and pre-manufactured cement slab	0.112
Building a new VIP latrine with a metal roof and pre-manufactured cement slab	0.102
Building a new VIP latrine with a thatched roof and self-constructed cement slab	0.149
Building a new VIP latrine with a metal roof and self-constructed cement slab	0.139

total average economic score were erratic and non-systematic. While in general the correlation coefficients were of the same order of magnitude, some latrine construction or maintenance components had positive correlations and some negative. In 4 out of the 16 (25%) willingness-to-pay scenarios measured, the higher economic status of a participant, the lower the amount they were willing to pay for the specific construction or maintenance component in the scenario and in 12 out of 16 (75%) of the scenarios the opposite was the case.

As discussed in the previous chapter, very few of the correlations between regression variables and the different willingness-to-pay scenarios achieved the requirements of statistical validity. Very few of the regression models in general achieved the requirement of statistical validity, with very low rates of variability in willingness-to-pay being explained by the regression model. This could have been caused by a high incidence of hypothetical bias, as hypothetical bias leads to random, disparate, and non-systematic willingness-to-pay data.

This finding could have also been caused by the timing of this research study, because the initial investment in sanitation infrastructure was most likely still fairly fresh in the study villages. Thus, it might be the case that people there were not likely to be concerned about future investments because they did not yet have time to experience the need for them. In fact, at the time of the study only a few of the latrines had collapsed or needed major repairs, and so only a few of the participants were intimately familiar with the purchases in question in the willingness-to-pay questions. A participant that has not experienced the need for a concrete slab, because their mud slab is still functional, is not likely to want to purchase a concrete slab and their willingness-to-pay should reflect this.

### 5.3: Overall Conclusions

Overall the objectives of this research study were fulfilled. The main hypotheses that CLTS produced sustained behavior change, increased demand for sanitation infrastructure, and is an effective and efficient means of increasing basic sanitation coverage were confirmed. Furthermore, the goal of assessing the importance of sanitation infrastructure in the daily lives of residents of open defecation free villages in Mopti, Mali was successfully completed.

Although, there was not much statistical validity found in the regression analysis or any correlations between willingness-to-pay data and socioeconomic data, we can still draw several conclusions from the general willingness-to-pay data. First, participants were willing to pay about 1500f CFA (US \$3.20) more for the materials to build a cement slab for their latrine, than they were for a pre-manufactured cement slab. This suggests to one looking to start a business selling pre-manufactured latrine slabs, that they must look for ways to bring significant discounts to the customer against building a slab on their own, while still maintaining an acceptable profit margin. The data also suggests that there is unmet demand for improvements to sanitation infrastructure, with 47.9% of latrines in the study area being unimproved. There also is a market for provision of maintenance and materials for maintenance of existing infrastructure, with 64.2% of respondents reporting having previously done some sort of maintenance of their existing latrines.

CLTS was proven to be an effective way of increasing the coverage of basic sanitation in Mopti region of Mali, West Africa. Within only a few years, the 6 villages in the study and 15 other villages in Mopti region gained open defecation free status

through the intervention of CLTS and hard work of the community members. The behavior change brought about by this intervention was sustained, and the people of these villages are healthier for it. In conclusion, a story that was told to the study team by a resident of Diongue-Bambara:

*Before CLTS came, this village was filthy. There were flies everywhere and the people were unhealthy. We were eating and drinking our own shit! Now, look around, there are no flies, you can smell cooking instead of shit, and the people are healthy...there was a cholera outbreak this rainy season that affected many villages in the area, but we did not have any cholera, because we have latrines...*

#### 5.4: Recommendations for Further Research

This research effort should be improved upon and repeated throughout Mali, and other areas of the world that have seen CLTS interventions. The main research instrument was successful in showing that the CLTS intervention was effective and that sanitation infrastructure had become an integral part of the residents of the study villages' lives. This research study does need to be improved and effort made to draw in a few other variables that were not specifically tested before it is repeated.

First, this research study did not test the effect that gender had on willingness-to-pay. The role of gender in willingness-to-pay for water and sanitation products and services is well documented (see Merrett, 2002; Gunatilake, et al., 2006; Pattanayak, et al., 2006). Research into gender roles and willingness-to-pay for sanitation would be very interesting in the Malian cultural context as well, because construction of infrastructure is seen as a man's job, while maintenance is woman's work. It would be interesting to see how these two roles work with each other (or do not work) to find an aggregate willingness-to-pay for sanitation infrastructure. It was decided early on by the

lead author of this thesis and study partners, however, that it was beyond the realm of this project to include gender as a factor affecting willingness-to-pay, simply because it would be difficult to find a statistically significant sample of women and the logistics of making sure the data is sound (especially with an all male study team).

Secondly, more research is needed into the sources of and occurrence of biases in willingness-to-pay studies, especially in the Malian cultural context. Specific studies should be done that test for the occurrence of specific biases within willingness-to-pay data, much like Onwujekwe (2004) study in Nigeria. In this study, the team tested specifically for certain biases as well as compared results of using different elicitation questions (e.g., iterative bidding, open-ended questions) for willingness-to-pay. This type of research, within the Malian cultural context, will make future willingness-to-pay studies more robust and give more statistically valid results that can be used policy making or Sanitation Marketing campaigns.

Thirdly, as previously mentioned the timing of this research study may not have been ideal. The participants may have need more time for their latrines to require further investment in order for them to become familiar with both the specific latrine construction and maintenance components in question and with requirements in general of owning and using a latrine in the long-term. It would therefore be interesting to assess how willingness-to-pay for maintenance and improvements changes over time, as more people experience the maintenance and improvements necessary to sustain the use of latrines long-term.

Finally, more research is needed in the area of Sanitation Marketing in Mali. Sanitation Marketing has been shown to be successful when combined with CLTS to

produce sustained behavior change in the long term and in moving people up the so-called “sanitation ladder” of improving sanitation infrastructure (see Rosenboom, et al., 2011). More research is needed however, on the specific workings of the local Malian sanitation business sector. How suppliers link up with merchants, merchants connect with customers, and how different groups should be involved in setting up microfinancing institutions to work alongside the sanitation market entrepreneurs and suppliers, are all very important and as yet largely unanswered questions in regards to getting Sanitation Marketing going throughout Mali.

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## Appendices

Appendix A: Questionnaire

Willingness to Pay for Improvements and Maintenance of Existing Sanitation Infrastructure

This questionnaire is strictly for academic purposes. This means that the answers to these questions only help us to understand Malians and Malian culture better. I am not part of any aid/development agency, I am here as a representative of the University of South Florida. The information provided by this questionnaire will help me and my colleagues to understand what is important to you in your daily lives and what you spend your money on. This information will be used to show the effectiveness of development programs that your village has taken part in. I am specifically looking at the effectiveness of behavior change and education programs. Thus, I will be asking a series of questions to see if the behavior changes brought on by these programs are sustainable (i.e. have you kept with the new behaviors or gone back to the old way of doing things). Your clear, honest, and complete answers are very much appreciated, and will help improve behavior change and education programs in Mali and around the world. That being said, you are free to stop this questionnaire at anytime, if you do not feel comfortable with the questions asked or have otherwise decided to stop participating. Thank you very much for your hospitality and time.

Please take five minutes to decide if you want to take part in this questionnaire. If you decide that you would like to be a part of this research, thank you very much, and if not, thank you as well for your time today.

Section 1: Demographics

First, I would like to know a little bit about you, you family, and your village.

Q1-1	Village:				
Q1-2	Quarter:				
Q1-3	Commune:				
Q1-4	Circle:				
Q1-5	Region:				
Q1-6	Sex:	Male:		Female:	
Q1-7	Age:				
Q1-8	Are you the head of your household?				
	Yes:		No:		
Q1-9	How many people live in this compound?				
Q1-10	How far to the nearest market town?				

Appendix A (continued)

Q1-11	Male Head of Household Education Level:				
	No School:		Started 1st Cycle:		
	Finished 1st Cycle:		Started 2nd Cycle:		
	Finished 2 <sup>nd</sup> Cycle:		Higher:		
Q1-12	Female Head of Household Education Level:				
	No School:		Started 1st Cycle:		
	Finished 1st Cycle:		Started 2nd Cycle:		
	Finished 2 <sup>nd</sup> Cycle:		Higher:		
Q1-13	Occupation:				
Q1-14	Is this a paid position?	Yes:		No:	
Q1-15	Interviewer notes:				

Section 2: Economic Indicators

Now, I would like to ask you more details about how your family lives their lives.

Q2-1	Does the family have (indicate how many):		
	Moto:		Car:
	Bicycle:		Donkey Cart:
	Other transport (specify):		
Q2-2	What is the primary source of income for the family?		
	Raising Livestock (if so go to Q2-3):		Running a small village store (if so go to Q2-6):
	Gardening (if so go to Q2-4):		Family member having a job (if so go to Q2-7):
	Farming (if so go to Q2-8)		

Appendix A (continued)

Q2-3	Does the family have (indicate how many, if main source of income is Raising Livestock only):			
	Cow:	<input type="text"/>	Sheep:	<input type="text"/>
	Goat:	<input type="text"/>	Chicken:	<input type="text"/>
	Donkey:	<input type="text"/>	Guinea Fowl:	<input type="text"/>
	Horse:	<input type="text"/>	Camel:	<input type="text"/>
	Other animals (specify): <input type="text"/>			
Q2-4	Does the family have a garden, if so what is grown and approximately how many kg per year are harvested (if main source of income is Gardening only):			
	Onion:	<input type="text"/>	Shallot:	<input type="text"/>
	Hot Peppers:	<input type="text"/>	Sweet Peppers:	<input type="text"/>
	Cucumber:	<input type="text"/>	Eggplant:	<input type="text"/>
	Aubergine:	<input type="text"/>	Carrot:	<input type="text"/>
	Potato:	<input type="text"/>	Sweet Potato:	<input type="text"/>
	Squash:	<input type="text"/>	Yam:	<input type="text"/>
	Okra:	<input type="text"/>	Cabbage:	<input type="text"/>
	Lettuce:	<input type="text"/>	Calabash:	<input type="text"/>
	Garlic:	<input type="text"/>	Tomato:	<input type="text"/>
	Tobacco:	<input type="text"/>	Beets:	<input type="text"/>
	Sweet Corn:	<input type="text"/>	Melon:	<input type="text"/>
	Other garden vegetables (specify): <input type="text"/>			
Q2-5	Does the family have fruit trees, if so what kind and approximately how many kg per year are harvested (if main source of income is Gardening only):			
	Mango:	<input type="text"/>	Lime:	<input type="text"/>
	Papaya:	<input type="text"/>	Orange:	<input type="text"/>
	Guava:	<input type="text"/>	Zabang:	<input type="text"/>
	Plantain:	<input type="text"/>	Banana:	<input type="text"/>
	Other fruit (specify): <input type="text"/>			
Q2-6	Place the family's store in one of the following categories:			<input type="text"/>
	Small store with no separate building and minimal merchandise (i.e. tea and sugar, cigarettes, soap, small candies, etc.)			
	Medium store with a separate build and minimal merchandise (i.e. tea and sugar, cigarettes, soap, small candies, cooking oil, etc.)			
	Big store with a separate build and large merchandise (i.e. rice, flour, pasta, biscuits, etc.)			<input type="text"/>
Q2-7	What is the occupation of the family member that supports this family (if main source of income is Job only)?			
	<input type="text"/>			

Appendix A (continued)

Q2-8 Approximately how many kg of these field crops to you sell per year (if main source of income is Farming only)?

Millet:	<input type="text"/>	Corn:	<input type="text"/>
Sorghum:	<input type="text"/>	Rice:	<input type="text"/>
Fonio:	<input type="text"/>	Peanuts:	<input type="text"/>
Beans:	<input type="text"/>	Hibiscus:	<input type="text"/>
Other (specify):	<input type="text"/>		

Q2-9 How many granaries does the family have?

Q2-10 Does the family have (indicate how many of each):

Television:	<input type="text"/>	Cell Phone:	<input type="text"/>
Radio:	<input type="text"/>		

Q2-11 Does the family receive remittances, if so how much and from whom/where:

Q2-12 What does the family sell in market?

Q2-13 Does the family ever make and sell things in village on non-market days?

Q2-14 What kind of house does the family have?

Mud brick w/ mud roof:	<input type="text"/>	Rock w/ mud roof:	<input type="text"/>
Rock w/ metal roof:	<input type="text"/>	Mud brick w/ metal roof:	<input type="text"/>
Cement w/ metal roof:	<input type="text"/>		
Other (specify):	<input type="text"/>		

Q2-15 Interviewer notes:

Appendix A (continued)

Section 3: Current Sanitation Practices

Now, I'm interested in the water and sanitation practices in your family and your community.

Interviewer: For this section ask the person interviewed to show you their latrine and water storage. Inspect the latrine and answer the following questions. \*Questions that don't have to be asked, are answered by observation. Also for this section "clean" will be defined as clear of debris and trash, "good working order" as functional and simple to use, and "well-kept" as neat, organized, and orderly. For a latrine to be judged "clean" the slab needs to be clear of trash, debris, and excrement; without flies; and without excessive odor. The latrine must also have a slab sufficient to stop contact between people and excreta, provided with some mechanism to stop the spread of flies (covered hole or ventilation), as well as a superstructure that will provide sufficient privacy. For a household to be judged "clean" it must be swept, having an enclosure for animals, and set up in order to keep animal and human excreta separate from cooking and living areas. Good judgment should be used within these broad definitions, however, and the final decision is left with the interviewer.

- Q3-1 Does the family currently have a functioning latrine in their compound, if not do they have access to one?  
Yes:  No:   
Explain:
- \*Q3-2 If they have a latrine, is it clean and in good working order?  
Yes:  No:   
Explain:
- Q3-3 Explain how to wash your hands:  
With soap:  Without soap:
- Q3-4 When do people in your family wash their hands (indicate which ones they mention)?
- |                                       |                      |                      |                      |
|---------------------------------------|----------------------|----------------------|----------------------|
| After using the latrine:              | <input type="text"/> | When preparing food: | <input type="text"/> |
| Before eating:                        | <input type="text"/> | When bathing:        | <input type="text"/> |
| After cleaning up a baby's excrement: | <input type="text"/> | Other (specify):     | <input type="text"/> |

Appendix A (continued)

Q3-5 If they have a latrine, what kind is it?

Simple Pit

w/ mud and stick slab:

w/ cement and rebar slab:

w/ hole cover:

w/ soak pit:

w/ mud privacy shelter

w/ cement privacy shelter

Ventilated-Improved Pit

w/ mud and stick slab:

w/ cement and rebar slab:

w/ soak pit:

w/ metal roof:

w/ thatch roof:

w/ mud privacy shelter

w/ cement privacy shelter

Pour-Flush

mud/rock construction:

cement construction:

Full-Flush Toilet

mud/rock construction:

cement construction:

EcoSan

mud/rock construction:

cement construction:

indicate number of chambers:

w/ urine diversion:

Other (specify):

Q3-6 How did the family build the latrine:

Built it themselves using mainly local materials:

Built it themselves using purchased materials (cement, etc.):

Paid someone to build it using mainly local materials:

Paid someone to build it using purchased materials:

Community group built using mainly local materials:

Community group built using purchased materials:

Collaborative build with a neighbor or small group:

Other:

Q3-7 How much did the family originally spend on each of these latrine components:

Pit:

Walls:

Soak-pit:

Slab:

Roof:

Ventilation:

Other (specify):

Q3-8 What repairs or maintenance has the family done to the latrine since construction and at what cost?

Q3-9 If they haven't repaired or improved the latrine, explain why:

Appendix A (continued)

\*Q3-10 Is the family compound/house clean and well-kept:  
 Yes:  No:   
 Explain:

Q3-11 Is there a pot for children's excrement in the concession or near the latrine?  
 Yes:  No:   
 Explain:

Q3-12 Does the family use soap to wash their hands before eating?  
 Yes:  No:

Q3-13 Do they all wash from one bowl or separately:  
 One bowl:  Separately:

Q3-14 Is their drinking water stored in covered containers:  
 Yes:  No:

Q3-15 Does the family treat their drinking water, if so how?  
 Yes:  No:   
 Explain:

Q3-16 What is the current source of household water:  
 Private Covered Well:  Private Uncovered Well:   
 Communal Covered Well:  Communal Uncovered Well:   
 Communal Hand Pump:  Private Hand Pump:   
 Surface Water:   
 Other (specify):

\*Q3-18 Interviewer notes:

Appendix A (continued)

Section 4: Willingness to Pay

The question in this section are hypothetical in nature. This means that these situations may not be true for you and your family or in your village, but if they were true what would you do.

Interviewer: For this section the “pair-wise ranking” process will be used to determine priority for a few questions. In this process, participants are asked to which of two choices are more important to them. After the first choice is made, they are asked if a third choice is more important than the winning choice of the first question, if so it is ranked the highest and you move on adding another choice. If the winning choice from the first question is also the winning choice from the second question, the two losing choices are compared and ranked.

Example 1: A vs. B – B is chosen; B vs. C – C is chosen; the ranking is: C – B – A

Example 2: A vs. B – A is chosen; A vs. C – A is chosen; B vs. C – B is chosen; ranking is: A – B – C

Q4-1 These beans represent your money. After buying enough food to feed your family this month, you have twenty (20) beans left. Do you spend these beans on (indicate how many beans go to each category):

Saving to buy seeds for next growing season:		Saving to buy another sheep/goat/cow:	
Saving to repair/improve your latrine:		Buying soap for hand washing and bleach for six months:	
Buying tea and sugar once a day for a month:		Buying new clothes for your children:	
Buying better food in market:		Buying meat for your family to eat once a day for two weeks:	

Q4-2 Your latrine has fallen down. Which of these essentials do you forgo in order to build a new latrine (first have the participants identify the top 5 easiest things to go without and then use “pair-wise ranking” to rank these 5 in order of ease of going without, number 1 – 5)

Tea and sugar twice a day for two weeks:		Meat for dinner everyday for two weeks:	
Three pagnes of fabric for a wedding in village:		New clothes for your children:	
Soap for hand washing and bleach for six months:		Gas for your motorcycle for two months:	
Building a new granary:		Building a new shade hanger:	
Feeding your family rice for two weeks:		Taking your child to the hospital when he/she gets sick:	

Appendix A (continued)

Q4-3 If you had enough money to buy all ten (10) of these items, which would you buy first. Put the following things in order of what you would buy (first have the participants identify the first 5 things they will purchase and then use “pair-wise ranking to number 1 – 5).

Bigger house:	<input type="text"/>	A new motorcycle:	<input type="text"/>
More fields:	<input type="text"/>	Build a garden:	<input type="text"/>
A private hand pump in your compound:	<input type="text"/>	The best latrine/toilet in village:	<input type="text"/>
More livestock to raise and sell or eat:	<input type="text"/>	Working cows and plows for your fields:	<input type="text"/>
Solar panel, battery, and television:	<input type="text"/>	Horses and cart to take people to and from market:	<input type="text"/>

Q4-4 You currently have a simple pit latrine, how much money would you be willing to pay for each of these incremental improvements (Interviewer: with this question and Q4-6, ask the interviewee if he/she would be willing to pay a denomination, start small and if they say yes keep increasing the price by 100f CFA until he/she says they would not pay that price.):

Cement and rebar for the slab:	<input type="text"/>	Sealing/lining the pit with cement:	<input type="text"/>
Thatched roof:	<input type="text"/>	Metal roof:	<input type="text"/>
Soak pit:	<input type="text"/>	Manufactured toilet pan:	<input type="text"/>
Cement block privacy shelter:	<input type="text"/>	Ventilation Pipe:	<input type="text"/>

Q4-5 How much are you willing to pay for these items of normal operation and maintenance of your sanitation infrastructure (Interviewer: see note on Q4-4 for instructions.):

Reconstruction with the pit is full:	<input type="text"/>	Maintaining the soak pit:	<input type="text"/>
Maintaining the super-structure:	<input type="text"/>	Buying soap for hand washing:	<input type="text"/>

Appendix A (continued)

Q4-6 Which of these latrine packages would you be most likely to buy (first have the participant pick the top 5 they are likely to buy and then use “pair-wise ranking” to rank from 1 – 5). Interviewer: ask this question to half of the survey participants and Q4-8 to half of the survey participants:

Build everything yourself with purchased materials (i.e. tools, cement, rebar, etc.).		Work with a community group to build your own and your neighbor's latrines with local materials (everyone pays a set price to the community group).	
Build everything yourself with local materials (i.e. mud bricks, rocks, sticks, etc.).		Work with a community group to build your own and your neighbor's latrines with purchased materials (everyone pays a set price to the community group).	
Pay someone to build.		Purchase a slab from a community group for 5000f CFA, build everything else yourself.	
Pay someone to do everything but digging the pit.		Have an NGO provide two-thirds (2/3) cost-share.	
Buy a manufactured slab in your market town, build everything else yourself.		Have an NGO buy materials for you and you build it yourself.	

Appendix A (continued)

Q4-7 Which of these latrine packages would you be most likely to buy (first have the participant pick the top 5 they are likely to buy and then use “pair-wise ranking” to rank from 1 – 5). Interviewer ask this question to half of the survey participants and Q4-7 to half of the survey participants:

Build everything yourself with purchased materials (i.e. tools, cement, rebar, etc.). Cost: 50 000f CFA		Work with a community group to build your own and your neighbor's latrines with local materials (everyone pays a set price to the community group). Cost: 2500f CFA	
Build everything yourself with local materials (i.e. mud bricks, rocks, sticks, etc.). Cost: 5000f CFA		Work with a community group to build your own and your neighbor's latrines with purchased materials (everyone pays a set price to the community group). Cost: 25 000f CFA	
Pay someone to build. Cost: 75 000f CFA		Purchase a slab from a community group for 5000f CFA, build everything else yourself. Cost: 7500f CFA	
Pay someone to do everything but digging the pit. Cost: 60 000f CFA		Have an NGO provide two-thirds (2/3) cost-share. Cost: 16 000f CFA	
Buy a manufactured slab in your market town, build everything else yourself. Cost: 15 000f CFA		Have an NGO buy materials for you and you build it yourself. Cost: 5000f CFA	

Q4-8 There are many people in villages that haven't reached ODF status, that do not have access to latrines. What do you think are the reasons that they do not have latrines? (Indicate the reasons mentioned)

They do not have enough money		They are embarrassed to use a latrine	
They do not know the dangers of open-defecation		They value the social aspects of open-air defecation	
They think that latrines are unsanitary		They are resistant to change common behaviors	
They do not know how to build latrines		They do not think that they are safe to use	
They do not think they need latrines		Other (specify)	

Appendix B: Questionnaire – French Translation

voionie de payer pour l'ameliortauon et l'entreuen des mirasutuures d'assainissement existants.

Ce questionnaire a un but purement académique. Cela signifie que les réponses à ces questions nous aideront seulement à mieux comprendre le Mali et la la culture malienne. Je ne fais partie d'aucune organisation caritative ni d'aucune ONG, Je suis là en tant que représentant d'une université de la Floride du Sud. Les informations que vous donnerez aideront, mes collègues et mon village à mieux comprendre ce qui est important pour vous au quotidien, et ce que vous dépensez avec votre argent. Cette information sera utilisée pour voir l'efficacité des programmes de développement auxquels votre village a participé Je cherche spécialement à voir un impact sur le changement de comportement et sur l'éducation sanitaire,

S'il vous plaît prendre cinq minutes pour décider, si voulez participer à ces questionnaires. Si vous décidez de participer à cette recherche, merci beaucoup, et si non , merci aussi pour votre temps.

Section 1: Démographie

D'abord, je voudrais avoir quelques informations sur vous, sur votre famille et sur votre village.

Q1-1	Village:				
Q1-2	Quartier:				
Q1-3	Commune:				
Q1-4	Cercle:				
Q1-5	Région:				
Q1-6	Sexe:	Homme :	<input type="text"/>	Femme :	<input type="text"/>
Q1-7	Age:	<input type="text"/>			
Q1-8	Êtes vous le chef de ménage?				
	Oui:	<input type="text"/>	Non:	<input type="text"/>	
Q1-9	Combien de personnes habitent dans cette concession?	<input type="text"/>			
Q1-10	Quelle distance d'ici à votre marché le plus proche?	<input type="text"/>			
Q1-11	Chef Homme du niveau d'éducation des ménages:				
	Aucune école:	<input type="text"/>	En route 1er cycle:	<input type="text"/>	
	Fini 1er cycle:	<input type="text"/>	En route 2e cycle:	<input type="text"/>	
	Fini 2e cycle:	<input type="text"/>	Plus :	<input type="text"/>	

Appendix B (continued)

Q1-12	Chef Femme du niveau d'éducation des ménages:			
	Aucune école:	<input type="text"/>	En route 1er cycle:	<input type="text"/>
	Fini 1er cycle:	<input type="text"/>	En route 2e cycle:	<input type="text"/>
	Fini 2e cycle:	<input type="text"/>	Plus :	<input type="text"/>
Q1-13	Occupation: <input type="text"/>			
Q1-14	Est-ce un travail salarié?	Oui: <input type="text"/>	Non: <input type="text"/>	
Q1-15	Notes de l'Interviewer:			
	<input type="text"/>			
	<input type="text"/>			

Section 2: Indicateurs économiques

Alors maintenant, je vais vous demander plus de détails sur comment votre famille gagne sa vie.

Q2-1	Est-ce que la famille possède (indiquent le nombre ce qui suit):			
	Moto:	<input type="text"/>	Voiture:	<input type="text"/>
	Bicyclette:	<input type="text"/>	Charrette :	<input type="text"/>
	Autre moyens de transport (à spécifier): <input type="text"/>			
Q2-2	Quelle est la principale source de revenu pour la famille ?			
	L'élevage (si oui allez à Q2-3):	<input type="text"/>	Exécution d'un boutique de village (si oui allez à Q2-6):	<input type="text"/>
	Jardinage (si oui allez à Q2-4) :	<input type="text"/>	Membre de la famille ayant un emploi (si oui allez à Q2-7):	<input type="text"/>
	Agriculture (si oui allez a Q2-8)	<input type="text"/>		
Q2-3	Est-ce que votre famille a (m'indiquer le nombre, si la source principale de revenus est l'élevage ne) :			
	Vache:	<input type="text"/>	Mouton	<input type="text"/>
	Chèvre	<input type="text"/>	Poulet	<input type="text"/>
	Âne	<input type="text"/>	Pintades	<input type="text"/>
	Cheval	<input type="text"/>	Chameau:	<input type="text"/>
	Autres animaux (à spécifier) <input type="text"/>			

Appendix B (continued)

Q2-4 Est-ce que la famille a un jardin, Si oui qu'est ce que vous cultivez et approximativement combien de kilos récoltez vous par an (si la source principale de revenus est le Jardinage ne)?

Oignon:		échalote	
Piment:		Poivrons :	
Concombre		Aubergine	
Aubergine:		Locale	
Pomme de		Carotte	
Terre		Patate	
Courge:		Douce	
Gombo		Igname	
Laitue		Choux	
L'ail		Calebasse	
Tabac		Tomate	
Mais Doux:		Betterave	
		Melon:	
Autres légumes (à spécifier):			

Q2-5 Votre famille possède-t-elle des arbres fruitiers, et si oui quels types d'arbres et approximativement combien de kg par récolté par an (si la source principale de revenus est le Jardinage ne) :

Mangue:		Citron:	
Papaye:		Orange:	
Goyave:		Zaban:	
Banane Plantain:		Banane:	
Autre fruit (à spécifier):			

\*Q2-6 Placez magasin de la famille dans l'une des catégories suivantes:  
Petit boutique sans bâtiment séparé et des marchandises minime (i.e. le thé et le sucre, les cigarettes, du savon, des petits bonbons, etc)

Boutique de moyenne avec une construction séparé et des marchandises minime (i.e. le thé et le sucre, les cigarettes, du savon, des petits bonbons, l'huile de cuisine, etc)	
Grand boutique avec une construction séparé et des marchandises de grande taille (i.e. riz, la farine, pâtes, biscuits, etc)	

Q2-7 Quelle est la profession du membre de famille qui soutient cette famille (si la principale source de revenu est seul Travail)?

--

Q2-8 Approximativement combien de kg vendez-vous par an (si la principale source de revenu est seul Agriculture)?

Millet :		Mais :	
Sorghum :		Riz :	
Fonio :		Arachide :	
Haricots :		Da :	
Autre (spécifier) :			

Appendix B (continued)

Q2-8 Votre famille a combien de greniers?

Q2-9 Votre famille a-t-elle ? (Indiquer le nombre de chaque):  
 Télévision:  téléphone cellulaire:   
 Radio:

Q2-10 Est-ce que votre famille reçoit des envois de fonds, si oui de qui, d'où et combien :

Q2-11 Est-ce que la famille fait des ventes au marché?

Q2-12 Est-ce que la famille fabrique ou confectionne des choses qui seront vendues dans le village les jours où il n'y a pas de marché?

Q2-13 Quelle sorte de maison a votre famille?

Maison et toiture en banco:	<input type="text"/>	En pierre avec toiture en banco	<input type="text"/>
En pierre couverte de tôles:	<input type="text"/>	En banco/ toiture en tôles :	<input type="text"/>
En ciment avec couvertures en tôles:	<input type="text"/>		
Autres types (à spécifier): <input type="text"/>			

Q2-14 Notes de l'Interviewer:

Appendix B (continued)

Section 3: Pratiques actuelles d'hygiène et d'assainissement

Maintenant , je vais m'intéresser aux pratiques d'eau et d'assainissement dans votre famille et dans votre communauté.

Interviewer: Pour cette section demander à la personne interviewée de vous montrer leur latrine et leur réserve d'eau. Inspecter la latrine et répondre à ce qui suit . \*Les Questions à ne pas poser, sont répondues par l'observation . Aussi pour cette section «propre» sera défini comme absence de débris et d'ordures , «Bonne condition de travail» comme fonctionnel et facile à utiliser, et «bien tenu» comme soigneux, organisé, en ordre. Pour une latrine pour être jugés «propres» de la dalle doit être clair d'ordures, les débris et les excréments, sans mouches, et sans odeur excessive. Les latrines doivent également avoir une dalle suffisante pour arrêter les contacts entre les gens et les excréments, muni d'un mécanisme pour arrêter la propagation des mouches (trou recouvert ou une ventilation), ainsi que d'une superstructure qui va assurer l'intimité suffisante. Pour un ménage d'être jugés «propres», il doit être balayé, ayant un enclos pour les animaux, et mis en place afin de garder des excréments humains et animaux distincte de la cuisine et des espaces de vie. Le bon jugement devrait être utilisé pour ces définitions, cependant, la décision finale sera laissée à l'interviewer .

- Q3-1 Est-ce que la famille possède présentement une latrine fonctionnelle dans la concession, si non ont -t-ils accès à une autre?  
Oui:  Non:   
Expliquer:
- \*Q3-2 S'ils ont une latrine, est-t-elle propre et en bonne condition d'utilisation?  
Oui:  Non:   
Expliquer:
- Q3-3 Expliquer comment se laver les mains:  
Avec du savon :  Sans savon :
- Q3-3 Lorsque les gens de votre famille se lavent les mains (indiquer lesquels ils mentionnent)?
- |  |                      |                                      |                      |
|--|----------------------|--------------------------------------|----------------------|
| Après avoir utilisé les latrines:          | <input type="text"/> | Lors de la préparation des aliments: | <input type="text"/> |
| Avant de manger:                           | <input type="text"/> | Quand la baignade:                   | <input type="text"/> |
| Après le nettoyage d'excréments d'un bébé: | <input type="text"/> | Autre (préciser):                    | <input type="text"/> |

Appendix B (continued)

Q3-4 S'ils ont une latrine, quel type est ce?

Simple fosse

Dalle en tiges de bois et de banco:

Dalle en ciment et fer:

Avec couvercle pour le trou :

Avec un puisard

Les murs en banco :

Les murs en ciment :

Avec chasse d'eau

Construction en banco/pierre:

construction en ciment:

EcoSan

construction en banco/pierre :

construction en ciment:

indiquer le nombre de chambres:

Avec diversion d'urine:

Fosse Ventilée et Améliorée (VIP) :

Dalle en tiges de bois et de banco:

Dalle en fer et ciment:

Avec un puisard:

Toiture en tôles:

Toiture de chaume ou paille:

Les murs en banco :

Les murs en ciment :

Toilette Avec chasse d'eau

Construction en pierre/banco:

Construction en ciment:

Autres (spécifier) :

Q3-5 Comment est ce que la famille a-t-elle construit la latrine?:

Construite par la famille elle-même en utilisant des matériaux locaux:

Payer quelqu'un pour le construire en utilisant principalement de matériaux locaux:

Construite par un groupe communautaire utilisant principalement des matériaux locaux:

Construite en Collaboration avec un voisin ou un petit groupe:

Construire soi même en utilisant des matériaux achetés (ciment, etc.):

Payer quelqu'un pour le faire en utilisant les matériaux achetés:

Construite par le Groupe communautaire utilisant des matériaux achetés:

Autre:

Q3-6

Combien la famille a-t-elle dépensé dans chacune des composantes de cette latrines:

le fosse:

les murs :

le puisard :

autre (spécifier):

la dalle :

le toit :

Ventilation:

Appendix B (continued)

Q3-7 Quelles sont les réparations ou maintenances opérées par la famille sur la latrine depuis sa construction, et cela à quels couts?

--

Q3-8 S'ils n'ont pas réparé ou amélioré la latrine, expliquer pourquoi:

--

\*Q3-9 Est-ce que la concession familiale est-elle bien propre et bien tenue:

Oui:  Non:

Expliquer:

Q3-10 Yait-il un pot pour les excréments des enfants dans la concession ou à proximité de la latrine?

Oui :  Non :

Expliquer :

Q3-11 si vous observez les repas avec la famille, lavent-ils leurs mains avec du savon avant de manger ?

oui:  Non:

Q3-12 Lavent -ils leurs mains dans un récipient commun ou dans des récipients séparés

Commun  Séparé :

Q3-13 L'eau est elle gardée dans des récipients couverts:

Oui:  Non:

Q3-14 La famille de traiter leur eau potable, si oui, comment?

Oui:  Non:

Expliquer:

Q3-15 Quelle est la source de courant d'eau des ménages :

Puits privé couvert:	<input type="checkbox"/>	Puits privé non couvert:	<input type="checkbox"/>
Puits communal couvert:	<input type="checkbox"/>	Puits communal non couvert:	<input type="checkbox"/>
Pompe manuelle communale:	<input type="checkbox"/>	Pompe manuelle privée:	<input type="checkbox"/>
Eau de Surface :	<input type="checkbox"/>		
Autres (spécifier): <input type="text"/>			

\*Q3-16 Notes de l'Interviewer :


Appendix B (continued)

Section 4 : Volonté de payer

Les questions de cette section sont hypothétique de nature,

Interviewer: pour cette section le processus de “classement par paires ” sera utilisé, afin de déterminer la priorité sur certaines questions. dans ce processus, on demandera aux participants lequel des deux choix est important à leurs yeux. Après que le premier choix est fait, ils sont demandé si un troisième choix est plus important que le choix gagnant de la première question, si c'est le cas il sera classé plus haut et on avance en ajoutant un autre choix. Si le choix gagnant de la première question est aussi ale choix gagnant de la deuxième question, les deux choix perdants seront comparés et classés.

Exemple 1: A contre. B – B est choisi; B contre C – C est choisi; le classement est : C – B – A

Exemple 2: A contre. B – A est choisi; A contre. C – A est choisi; B contre. C – B est choisi; le classement est : A – B – C

Q4-1 Ces graines de haricot représentent votre argent. Après avoir acheté assez de nourriture pour votre famille ce mois, il vous reste vingt (20) haricots. vous allez dépenser ces haricots sur (indiquer combien de haricots par catégorie):

épargner pour acheter des semences pour la saison agricole a venir:		épargner pour acheter un autre mouton/chèvre/vache:	
épargner pour /améliorer la latrine:		Acheter du savon et de l'eau de javel pour laver les mains pendant six mois :	
Acheter du thé et du sucre une fois par jour pendant un mois:		Achat de nouveaux habits pour les enfants:	
Achat de meilleures nourriture au marché:		Achat de viande une fois par jour ,pour la consommation familiale pendant deux semaines:	

Q4-2 Votre latrine s'est écroulée. Laquelle de ces nécessités allez vous mettre de coté afin de de réaliser une nouvelle latrine (Choisir le haute 5 et utiliser “le classement par paires” pour classer par ordre de facilité du, nombre 1 - 5):

Le thé et le sucre deux fois par jour pendant deux semaines:		La viande au diner chaque jour pendant deux semaines:	
Trois pagnes pour un mariage dans le village:		De nouveaux habits pour vos enfants:	
Le savon pour se laver les mains et l'eau de javel pendant six semaines:		le carburant pour moto pendant deux mois:	
La construction d'un nouveau grenier:		Confection d'un nouveau hangar:	
Nourrir la famille de riz pendant deux semaines		Amener votre enfant à l'hôpital quand il/elle est malade:	

Appendix B (continued)

Q4-3 Si vous aviez assez d'argent pour acheter ces (10) articles, lequel achèteriez vous le premier. Classer les choses suivantes selon l'ordre d'achat (Choisir le haute 5 et utiliser "le classement par paires de 1 à 5).

Plus grande maison:	<input type="text"/>	Une nouvelle moto :	<input type="text"/>
plus de champs:	<input type="text"/>	Faire un jardin:	<input type="text"/>
Une nouvelle pompe dans votre concession	<input type="text"/>	La meilleure latrine/toilette dans le village:	<input type="text"/>
Plus de bétail pour la vente et la consommation:	<input type="text"/>	Des bœufs de labours et des charrues pour votre champs :	<input type="text"/>
Un panneau solaire/une batterie/et une télévision:	<input type="text"/>	Des chevaux et charrettes pour le transport des gens pour aller au marché, et en provenance du marché:	<input type="text"/>

Q4-4 Vous avez présentement une latrine ordinaire avec un simple fosse, combien d'argent voudriez vous payer pour chacune de ces améliorations incrémental (Interviewer : avec cette question et Q4-5, demander à l'interviewé s'il / elle serait prête à payer une dénomination, commencer petit et si ils disent oui continuer à augmenter le prix par 100f CFA jusqu'à ce qu'il / elle dit qu'ils ne seraient pas payer ce prix.) :

Ciment et fer pour la dalle (5000f CFA) :	<input type="text"/>	Fixation/nivellement /du fosse avec le ciment (5000f CFA) :	<input type="text"/>
Toiture en paille (1000f CFA) :	<input type="text"/>	Les feuilles de tôles (7000f CFA) :	<input type="text"/>
Le puisard (5000f CFA) :	<input type="text"/>	Le dalle manufacturé (6000f CFA) :	<input type="text"/>
Brique de ciment d'abri privé (10 000f CFA) :	<input type="text"/>	Tuyau de ventilation (2500f CFA) :	<input type="text"/>

Q4-5 Combien de francs consentez vous a payer pour ces articles d'utilisation normale et la maintenance de votre structure d'assainissement (Interviewer: voir notes questions Q4-4 pour instructions.):

Vider la fosse (5000f CFA) :	<input type="text"/>	Entretien du puisard (2000f CFA) :	<input type="text"/>
Entretien de la super structure (2000f CFA) :	<input type="text"/>	Achat du savon pour laver les mains (2000f CFA) :	<input type="text"/>

Appendix B (continued)

Q4-6 Lesquels de ces paquets de latrine voudriez probablement acheter (Choisir le haute 5 et utiliser "le classement par paires" classer de 1 à 5) Interviewer: poser cette question à la moitié des participants au sondage et au Q4-7 de la moitié des participants à l'enquête :

<p>Réaliser tout vous-même avec des matériaux achetés (i.e. outils, ciment, fer, etc.). Cout: 50 000f CFA</p>		<p>Travailler avec un groupe de la communauté pour réaliser votre propre toilette, et ceux des voisins avec des matériaux locaux(chacun paiera un prix fixe au groupe de communauté). Cout: 2500f CFA</p>	
<p>Réalise tout toi-même avec des matériaux locaux (i.e. briques en banco, roches, tiges de bois, etc.). Cout: 5000f CFA</p>		<p>travailler avec la communauté pour réaliser votre latrine et celles de vos voisins avec des matériaux achetés (chacun paie un prix fixe à la communauté). Cout: 25 000f CFA</p>	
<p>Payer quelqu'un pour le faire. Cout: 75 000f CFA</p>		<p>Acheter une dalle avec un groupe de la communauté 5000f CFA, construire tout vous même. Cout: 7500f CFA</p>	
<p>Payer quelqu'un pour faire le tout sauf creuser le fosse. Cout: 60 000f CFA</p>		<p>Avoir une ONG qui va fournir les (2/3) du cout. Cout: 16 000f CFA</p>	
<p>Acheter une dalle manufacturé au marché local, réaliser le reste vous même Cout: 15 000f CFA</p>		<p>Une ONG achètera les matériaux et vous réalisez les travaux vous même Cout: 5000f CFA</p>	

Appendix B (continued)

Q4-7 Lesquels de ces paquets de latrine voudriez probablement acheter (Choisir le haute 5 et utiliser "le classement par paires" classer de 1 à 5). Interviewer: poser cette question à la moitié des participants au sondage et au Q4-6 de la moitié des participants à l'enquête:

Réaliser tout vous-même avec des matériaux achetés (i.e. outils, ciment, fer, etc.).		Travailler avec un groupe de la communauté pour réaliser votre propre toilette, et ceux des voisins avec des matériaux locaux(chacun paiera un prix fixe au groupe de communauté).	
Réalise tout toi-même avec des matériaux locaux (i.e. briques en banco, roches, tiges de bois, etc.).		travailler avec la communauté pour réaliser votre latrine et celles de vos voisins avec des matériaux achetés (chacun paie un prix fixe à la communauté).	
Payer quelqu'un pour le faire.		Acheter une dalle avec un groupe de la communauté 5000f CFA, construire tout vous même.	
Payer quelqu'un pour faire le tout sauf creuser le fosse.		Avoir une ONG qui va fournir les (2/3) du cout.	
Acheter une dalle manufacturé au marché local, réaliser le reste vous même.		Une ONG achètera les matériaux et vous réalisez les travaux vous même.	

Q4-8 Il-y beaucoup de gens dans le village qui n'ont pas atteint le statut (FeDAL) et qui n'ont pas accès au latrines. Selon vous quelles seraient les raisons qui font qu'ils n'ont pas de latrines:

Ils n'ont pas assez d'argent		Ils se gênent a utiliser une latrine	
Ils ne savent pas les dangers de la défécation a plein air :		ils valorisent les aspects sociaux de la défécation à plein air :	
Ils pensent que les latrines ne sont pas saines		Ils sont résistants à changer les comportements communs	
Ils ne savent pas comment réaliser des latrines		Ils ne pensent être en sécurité à utiliser la latrine	
Ils pensent qu'ils n'ont pas besoin de latrines		Autre (à spécifier)	

Appendix C: Letter from IRB



DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE

Institutional Review Boards, FWA No. 00001609  
12901 Bruce B. Downs Blvd., MDC055 • Tampa, FL 33613-4799  
(813) 974-6618 • FAX (813) 974-5610

Justin Meeks  
Civil & Environmental Engineering  
421 2<sup>nd</sup> St. NE  
Cut Bank, MT 59427

RE: **Accepted and Reported Reportable Event**

IRB#: Pro00005502

Title: Willingness to Pay for Improvements and Maintenance to Existing Sanitation Infrastructure in Open-Defecation Free Villages in the Mopti Region of Mali, West Africa

Dear Mr. Meeks,

On 1/20/2012 the Institutional Review Board (IRB) reviewed and accepted the following noncompliance:

The research project, conducted to fulfill the requirements of the PI's master's thesis, was conducted prior to obtaining departmental and IRB approval.

This noncompliance was considered:

- Non-serious
- Non-continuing
- Did not increase risk to subjects
- No further action is needed.

The Board further determined that you may use the data collected in the research effort.

While it is important that you recognize that no research should proceed unless formal IRB approval has been granted, the Committee did recognize that extenuating circumstances (i.e., departmental failure to review the protocol on a timely basis) played a large part in the non-compliance.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,



John Schinka, PhD, Chairperson  
USF Institutional Review Board

Cc: Anna Davis, USF IRB Professional Staff

## Appendix D: Raw Data

	Age	Family Size	M – Education	F – Education	M-Koranic	F-Koranic	Literacy	Occupation	Paid job?
Abdoul-Karim	48	44	1	1				Farmer	0
	46	19	1	1				Farmer	0
	75	32	2	1				Farmer	0
	51	8	1	1				Farmer	0
	48	20	1	1				Farmer	0
	63	60	1	1				Farmer	0
	60	25	3	1	10			Farmer	0
	33	3	1	1	20			Farmer	0
	32	8	1	1				Farmer	0
	62	98	1	1	20			Farmer	0
	75	30	1	1				Farmer	0
	64	25	2	1	5			Farmer	0
	61	40	1	1				Farmer	0
	55	30	1	1				Farmer	0
	42	15	3	1				Village Relay	0
Bama	43	35	1	1				Farmer	0
	41	25	1	1				Farmer	0
	40	25	1	1				Farmer	0
	31	30	2	1				Farmer	0
	50	28	1	1				Farmer	0
	28	20	1	1				Farmer	0
	21	4	6	1				Mason	0
	50	50	1	1				Farmer	0
	50	30	1	1				Farmer	0
	40	30	1	1				Agricultural Business	0
	26	36	1	1				Farmer	0
	33	15	1	1				Farmer	0
	70	15	1	1				Farmer	0
	30	13	4	2				Farmer	0
Biba	55	15	1	1				Farmer	0
	56	23	2	1	8			Village Relay	0
	54	7	2	1			1	Farmer	0
	60	12	1	1				Farmer	0
	65	100	1	1	5	3		Farmer	0
	40	6	1	1				Herder	0
	52	45	1	1				Farmer	0
	35	8	1	1				Farmer	0
	40	30	1	1				Farmer	0
	44	14	1	1	13			Farmer	0
	46	15	1	1				Farmer	0
	54	15	1	1				Farmer	0
	54	23	1	1	15			Farmer	0
	67	5	1	1				Farmer	0
	62	11	2	1				Farmer	0

Appendix D (continued)

	Age	Family Size	M- Education	F- Education	M-Koranic	F-Koranic	Literacy	Occupation	Paid job?
Diaba-Peulh	40	16	4	1				Traditional Healer/M	0
	30	8	1	1			1	Village Relay	0
	70	60	2	1				Farmer	0
	40	35	2	1				Farmer	0
	66	11	1	1				Farmer	0
	56	7	2	1				Herder	0
	62	16	2	1				Farmer	0
	46	12	2	1				Farmer	0
	47	8	2	1				Farmer	0
	64	100	1	1				Farmer	0
	62	13	2	1				Imam	0
	38	6	1	1			1	Tax Collector	1
	31	7	1	1				Farmer	0
	49	6	1	1	20			Farmer	0
	75	7	1	1	15			Koranic Teacher	0
	48	15	1	1				Farmer	0
Diongue-Bambara	80	30	1	1				Farmer	0
	70	100	1	1	20			Farmer	0
	58	64	1	1				Farmer	0
	71	21	1	1				Farmer	0
	62	43	1	1				Farmer	0
	56	30	1	1	20			Imam	0
	61	11	1	1	9			Farmer	0
	75	31	1	1				Farmer	0
	90	18	1	1				Farmer	0
	54	22	1	1				Farmer	0
	53	15	1	1				Farmer	0
	40	10	1	1			1	Blacksmith	0
	55	13	1	1			1	Farmer	0
	38	3	1	1				Farmer	0
	72	42	1	1				Farmer	0
Ene	40	30	1	1				Farmer	0
	63	30	1	1				Farmer	0
	40	26	1	1				Farmer	0
	43	7	1	1				Farmer	0
	38	50	1	1				Farmer	0
	41	13	2	1			1	Village Relay	0
	60	40	1	1				Farmer	0
	34	7	1	1				Farmer	0
	60	6	1	1				Farmer	0
	65	16	1	1				Farmer	0
	25	14	3	1				Farmer	0
	52	64	1	1				Farmer	0
	47	103	1	1				Agricultural Business	0
	60	24	1	1				Farmer	0
	53	70	1	1				Farmer	0
	60	40	1	1				Farmer	0
	32	30	1	1	15			Farmer	0
	70	20	1	1				Farmer	0
	57	34	1	1				Farmer	0
	42	34	1	1				Mason	0

Appendix D (continued)

	Transportation	Primary	Secondary	Job	Store	Granaries	Media	Remittances	Market Sales	In Village Sales	Housing	Economic Score
Abdoul-Karim	2	2	2	0	0	5	2	0	1	1	3	3
	3	1	1	0	0	2	2	1	1	3	3	2
	4	5	5	5	5	2	5	0	5	5	5	4
	2	4	1	4	0	1	4	0	1	1	3	2
	3	4	3	4	0	2	3	1	1	4	3	3
	2	1		0	0	5	3	0	1	1	3	3
	3	2		0	0	2	1	1	1	4	3	2
	2	2		0	0	1	1	0	1	4	3	1
	2	5	1	5	0	1	1	1	1	1	3	2
	5	4	3	0	3	5	5	0	1	3	3	4
	2	2		0	0	1	2	0	1	1	3	2
	3	3		0	0	3	3	0	1	4	3	3
	5	3		0	0	5	5	1	1	3	3	5
	4	3		0	0	2	3	1	1	1	3	3
	3	5	1	5	0	1	4	0	3	3	3	3
Bama	3	2	3	0	0	5	3	0	1	2	3	3
	2	2		0	0	4	5	0	3	2	3	3
	5	3		0	0	5	4	1	2	2	3	4
	2	5		5	0	4	5	1	3	2	3	4
	2	4		0	0	1	1	0	1	2	3	2
	2	2		0	0	1	4	0	1	2	3	2
	2	4		4	0	1	3	0	4	3	3	2
	4	5		0	5	5	5	0	3	2	3	5
	4	4	2	0	4	2	4	0	2	2	3	3
	4	5	3	5	0	5	3	0	3	3	3	4
	2	2		0	0	1	3	0	4	4	3	2
	2	2		0	0	1	1	0	2	2	3	2
	2	3		0	0	1	1	0	1	1	3	2
	2	3		0	0	1	3	1	1	1	3	2
Biba	2	5		3	0	1	4	1	3	4	3	3
	3	3		5	0	3	5	1	1	2	3	4
	2	5		0	0	2	5	0	4	3	3	4
	2	5	1	0	0	2	1	1	3	3	3	2
	5	4	3	0	4	5	5	1	5	3	3	4
	2	2		0	0	1	2	0	1	3	5	2
	4	2		0	0	5	5	1	3	3	3	4
	2	5	1	5	0	1	2	1	1	1	3	2
	4	3	5	5	0	3	5	1	1	2	3	4
	3	5	2	5	3	1	5	1	1	1	3	3
	3	2		0	0	2	2	1	1	1	3	2
	2	2		0	0	2	2	0	4	4	3	2
	3	2		0	0	2	5	1	1	3	3	3
	1	4	1	3	0	1	1	0	1	4	3	2
	2	2		0	0	2	5	1	1	2	3	3

Appendix D (continued)

	Transportation	Primary	Secondary	Job	Store	Granaries	Media	Remittances	Market Sales	In Village Sales	Housing	Economic Score
Diaba-Peulh	2	5	3	5	3	1	5	1	1	1	5	3
	1	1		0	0	1	3	1	1	3	3	2
	3	4		0	0	1	3	1	1	2	3	3
	4	5	1	5	0	1	5	1	4	1	3	3
	2	2	1	0	0	2	1	1	1	1	5	2
	1	2		2	0	1	1	1	1	2	3	1
	2	2		0	0	5	2	1	1	3	3	3
	2	2	1	1	0	1	2	1	4	1	3	2
	2	2		0	0	2	2	0	1	1	3	2
	4	3		0	0	4	5	1	4	1	3	4
	2	3	1	3	0	1	4	1	1	1	3	2
	1	5		5	0	1	2	0	4	2	5	2
	3	3	4	4	0	1	5	1	1	2	5	3
	2	2		0	0	1	1	1	2	2	3	1
	1	5	2	5	0	1	2	0	2	1	3	2
	2	3		0	0	2	1	0	1	1	3	2
Diongue-Bambara	4	2		0	0	3	5	1	1	1	3	3
	4	2		0	0	2	5	1	3	1	3	3
	4	4	2	4	0	5	4	1	3	2	3	4
	3	2		0	0	2	2	1	2	1	3	2
	3	2		0	0	3	5	1	1	1	3	3
	2	4	1	4	0	1	2	0	1	1	3	2
	2	5		5	0	2	3	0	1	1	3	3
	4	2		0	0	2	5	1	3	1	3	3
	2	4		0	0	2	2	1	1	1	3	3
	4	2		0	0	4	5	0	3	1	3	4
	3	1		0	0	1	2	1	3	3	3	2
	2	5		5	0	1	5	1	3	3	3	3
	2	2		0	0	2	4	0	1	2	3	2
	3	2		0	0	2	5	1	1	4	5	3
	3	4	1	4	0	2	5	1	4	3	5	3
Ene	4	2		0	0	5	5	1	1	2	3	4
	4	2		0	0	2	5	0	3	1	3	3
	4	2		0	0	5	5	1	3	2	3	4
	2	4		0	0	1	2	1	1	1	4	2
	4	4		0	0	4	5	1	3	1	3	4
	3	1		0	0	2	2	0	1	1	3	2
	2	1		0	0	4	2	0	4	4	3	2
	2	1		0	0	1	3	0	1	1	3	2
	2	1		0	0	2	2	1	1	5	3	2
	2	2		0	0	2	1	0	1	1	3	2
	3	3	4	0	4	4	3	0	1	1	3	3
	5	3		0	0	5	5	0	3	3	3	5
	5	5	5	5	5	5	5	0	4	3	5	5
	2	3		0	0	3	1	1	1	3	3	2
	4	5	4	0	0	3	3	0	1	3	3	4
	4	5		5	0	5	4	0	1	2	3	4
	4	3		0	0	5	5	0	1	3	3	4
	4	1		0	0	4	5	1	3	2	3	3
	4	2		0	0	5	5	0	3	4	3	4
	3	4	1	4	0	2	4	0	1	1	3	3

Appendix D (continued)

	Q3-1	Q3-2	Q3-3	Q3-13	Q3-4						
	# Latrines	good?	soap?	common/separa	after latrine	cooking	before eat	bathing	baby	prayer	after work/dirty
Abdoul-Karim	2	2	1	common	1		1				
	2	2		common	1		1				
	4	4	1	separate	1		1				
	1	1	1	common	1		1				
	2	2	1	separate	1		1				
	3	3		common	1		1				
	2	2		separate	1		1				
	neighbor			common	1		1				
	1	1		separate	1		1				
	5	lid not on		separate	1		1				
	2	2		common	1		1				
	1	1		common			1			1	
	7	7	1	common	1		1			1	
	3	3	1	common	1		1				
	2	2	1	separate	1		1			1	
Bama	1	lid not on	1	common			1	1			
	2	2		separate			1			1	
	1	1	1	separate	1		1				
	4	1	1	separate	1		1				
	collapsed/neighbor		1	separate	1		1				
	1	no lid		common			1				
	1	1		common			1				
	1	1	1	common	1		1	1			
	4	4	1	common			1				
	1	lid not on	1	common	1		1				
	2	no lid		common			1	1			
	1	no lid		common	1		1				
	1	1	1	common	1		1				
	2	2	1	separate	1		1	1			
Biba	1	1	1	common	1		1				
	2	2	1	common	1	1	1				
	3	3	1	separate	1	1	1	1	1		
	1	no lid	1	common	1		1				
	5	5	1	common	1	1	1		1		
	1	1	1	separate	1		1		1		
	2	2	1	separate	1		1				
	1	1	1	common	1		1		1		
	1	1	1	common	1		1	1	1	1	
	1	1		common	1		1				
	2	2	1	separate	1		1				
	1	1	1	common	1		1				
	2	2	1	common	1		1				
	1	1	1	common	1		1				
	2	2	1	common	1		1				
	1	1	1	common	1		1				
	2	2	1	common	1		1				

Appendix D (continued)

	Q3-1	Q3-2	Q3-3	Q3-13	Q3-4						
	# Latrines	good?	soap?	common/separate	after latrine	cooking	before eat	bathing	baby	prayer	after work/dirty
Diaba-Peulh	4	2	1	common	1		1		1		
	1	no lid	1	common	1		1		1		
	2	2	1	separate	1		1				
	2	2	1	common	1		1				
	1	1	1	common	1		1				
	neighbor			common			1			1	
	1	1	1	common	1	1		1			
	1	lid not on	1	common	1		1	1			
	2	no lid	1	common	1		1				
	3	3	1	common	1		1				
	1	no lid	1	common	1		1				
	1	1	1	common	1		1		1		
	1	1	1	common	1		1	1			
	1	1		common	1		1			1	
	1	1	1	common	1		1				
1	1	1	separate	1		1					
Diongue-Bambara	8	8		common	1		1			1	
	11	11	1	common	1		1				
	8	8		common	1		1				
	6	6	1	common	1		1				
	5	5	1	common	1						
	3	3		separate			1				
	2	2	1	common	1		1		1		
	4	4	1	common	1		1	1			
	3	2		common	1		1				
	2	2	1	common	1		1				
	2	2	1	separate	1						1
	1	1	1	separate			1				
	1	1	1	separate	1		1				
	1	no lid		separate	1		1	1			
	1	1	1	separate	1		1				
Ene	1	no lid	1	common	1		1			1	
	1	1		common	1		1			1	
	1	1	1	common	1		1				
	collapsed/neighbor		1	separate	1		1				
	1	1	1	common	1		1				
	1	no lid	1	separate	1		1				
	1	no lid	1	common			1				
	1	1	1	common	1		1				
	1	1	1	common	1		1				
	1	1	1	common	1		1				
	1	1	1	common	1	1	1				
	1	no lid		common	1		1				
	2	2		common	1		1				
	1	no lid	1	common			1				1
	1	lid not on		separate			1	1		1	
1	no lid		common	1		1	1				
1	no lid		common	1		1					
1	lid not on	1	common	1					1		
1	1		separate	1		1	1				
1	1	1	common			1	1				

Appendix D (continued)

	Q3-5							soak pit
	mud slab	mud w/ cement slab	cement slab	lid	mud shelter	mud w/ cement shelter	cement shelter	
<b>Abdoul-Karim</b>	1		1	2	2			
	1		1	2	2			
	1		3	4	4			
			1	1	1			
	1		1	2	2			
	1		2	3	3			
	1		1	2	2			
			1	1	1			
	3		2	5	5			1
	1		1	2	2			
	1		1	1	1			
	4		3	7	7			
	3			3	3			
	1		1	2	2			
<b>Bama</b>			1	1		1		
			2	2	2			2
			1	1	1			
	1		3	1	4			
			1			1		
			1	1	1			
			4	4		4		
			1	1	1			
			2		2			
			1		1			
			1	1	1			
			2	2	2			
<b>Biba</b>		1		1	1			
		1	1	2	2			
	3			3	3			
	1				1			
		5		5	5			
		1		1	1			
		2		2	2			2
		1		1	1			1
		1		1	1			
	1		1	1	1			
	1		1	2	2			
	1			1	1			
	2			2	2			2
		1		1	1			
	2			2	2			

Appendix D (continued)

	Q3-5							
	mud slab	mud w/ cement slab	cement slab	lid	mud shelter	d w/ cement she	cement shelter	soak pit
Diaba-Peulh		4		2	4			
		1			1			
		2		2	2			
	1	1		2	2			
	1			1	1			
		1		1	1			
	1			1	1			
	2			2	2			
		3		3	3			
	1			1	1			
	1			1	1			1
	1			1	1			1
	1			1	1			
	1			1	1			
Diongue-Bambara	4		4	8	8			
	10		1	11	11			
	8			8	8			
	5		1	6	6			
	5			5	5			
	3			3	3			
	2			2	2			
	3		1	4	4			
	3			2	3			
	2			2	2			2
	2			2	2			
	1	1		1	1			
	1	1		1	1			
Ene			1	1	1			
			1	1	1		1	
			1	1	1			
			1	1	1			
			1	1	1			
			1	1	1			
			1	1	1			1
			2	2	1	1		2
			1	1	1			
			1	1	1			
			1	1	1			
			1	1	1			
			1	1	1			
			1	1	1			1

Appendix D (continued)

	Q3-6								Q3-7					
	self local	self import	paid local	paid import	group local	group import	collaborative	sted/subsidized	pit	slab	walls	soak pit	mason	total cost
Abdoul-Karim	2							1	15000					15000
	2							1		1000				1000
	3		1					3	7000	2000	7500		2000	18500
	1							1						
			2					1	10000				in kind	10000
	3							2		1000				1000
	2							1		500				500
	1							1						
	5							2						
	2							1	5000					5000
	1													
	7							7						
	3													
	2							1	5000					5000
Bama		1						1		4500				4500
	2							2		7000				7000
	1							1		5000				5000
	4							3		7500				7500
		1						1						
	1							1		1000				1000
		1						1						
		4						4		16000				16000
	1							1		4000				4000
	2							2		8000				8000
	1							1		5000				5000
	1							1		5000				5000
	2							2		9000				9000
Biba	1													
										7500				7500
	3													
	1													
	5									12500				12500
	1								2500	1500	3500			7500
	2									2400				2400
	1									2000				2000
	1								4000	6000	1500			11500
	1													
	2									4000				4000
	1													
	2													
	1								1500	1000				2500
	2													

Appendix D (continued)

	Q3-6								Q3-7					
	self local	self import	paid local	paid import	group local	group import	collaborative	sted/subsidized	pit	slab	walls	soak pit	mason	total cost
Diaba-Peulh			4				1		34500	22450	12000			68950
										600				600
	2								10000	13000				23000
	2								4000	7000	11000			22000
	1													
	1										175			175
	1													
	1								300		2000			2300
	3								15000	6000				21000
	1								4000					4000
	1													
	1								15000					15000
	1										2500			2500
	1													
	1													
Diongue-Bambara	8													
	11													
	8										12000			12000
	6													
	5													
	3													
	2									500				500
	4												500	500
	3									60000				60000
	2									12000				12000
	2													
	1									6000				6000
	1													
	1									5000				5000
	1													
Ene	1									5000				5000
		1								5750				5750
	1									5000				5000
	1									7500				7500
	1													
	1									5000				5000
					1									
	1													
	1									5000				5000
	1									7500				7500
	1													
	2									10000				10000
	1													
	1									5500				5500
	1									5000				5000
	1									7500				7500
	1									15000	5000			20000
	1									5250				5250
	1													

Appendix D (continued)

	Q3-8		Q3-9	Q3-11	Q3-15		Q3-16							
	maintenance	m cost	improve	kid pot	dw treatment	type	PCW	PUW	CCW	CUW	CHP	PHP	SW	W/P treatment
Abdoul-Karim	1	1500	no money	1			1							2 months
	1		no money	1	1	aquatab		1						1 month
			not needed	1	1	bleach		1						none
	1		not needed	1				1						none
			no money	1	1	aquatab	1							none
	1		not needed	1				1						none
	1		no money	1		only when told to	1							none
				no kids				1						none
			not needed	1					1					1 week
	1		no money	1				1						none
			no money	1		only when told to	1							none
			not needed	OD			1							1 year
	1		no money	1		only when told to	1							none
	1		no money	1			1							none
	1		no money	1				1						none
Bama	1	3500	not needed	1	1	bleach				1				none
			not needed	1						1				none
			not needed							1				none
	1	250	not needed	1						1				none
				1	1	bleach				1				none
	1		not needed		1	decanting				1				none
	1		not needed	no kids						1				none
			not needed	1	1	bleach			1					none
			not needed						1					none
	1		not needed	1						1				none
			not needed						1					none
	1		not needed		1	bleach				1				none
	1		not needed						1					none
	1	525	not needed	1						1				none
Biba	1	3750	continuous	1	1	bleach					1			N/A
	1	6000	continuous	1							1			N/A
	1		no money	1	1	each or aquatabs					1			N/A
	1		no money	1	1	bleach					1			N/A
	1		continuous	1	1	bleach					1			N/A
	1	600	continuous	1	1	bleach					1			N/A
	1	600	no money	1	1	bleach					1			N/A
	1	750	no money	1	1	bleach					1			N/A
	1	2500	no money	1	1	bleach					1			N/A
	1		continuous	1	1	each or aquatabs					1			N/A
	1		no money	1	1	bleach			1					1 month
	1		no money	no kids							1			N/A
	1		no money	1							1			N/A
	1		no money	no kids	1	bleach					1			N/A
	1		no money	no kids	1	bleach					1			N/A

Appendix D (continued)

	Q3-8		Q3-9	Q3-11	Q3-15		Q3-16							
	maintenance	m cost	improve	kid pot	dw treatment	type	PCW	PUW	CCW	CUW	CHP	PHP	SW	W/P treatment
Diaba-Peulh	1		continuous	1							1			N/A
	1		no money	1							1			N/A
	1		no money	1	1	bleach					1			N/A
	1		continuous	OD	1	bleach					1			N/A
	1		no money	1							1			N/A
				no kids	1	cloth filter				1				none
	1		saving	1						1				none
			saving	1							1			N/A
	1		no money	1							1			N/A
	1		no money	1							1			N/A
	1		no money	1							1			N/A
	1		no money	1							1			N/A
	1		no money	1							1			N/A
			not needed	no kids							1			N/A
	1		no money	no kids							1			N/A
			no money	1					1					3 month
Diongue-Bambara			no money	1					1					2 months
			no money		1	bleach				1				2 months
	1	1000	no money	1					1					2 months
	1		no money	1	1	cloth filter				1				2 months
	1		no money							1				2 months
	1		no money						1					2 months
			waiting for NGO	1					1					2 months
	1		no money	1						1				2 months
	1		continuous	1						1				2 months
	1	150	continuous	1	1	aquatab			1					2 months
	1		no money	1	1	aquatab				1				2 months
	1		not needed	1	1	bleach			1					2 months
	1		no money						1					2 months
			not needed		1	aquatab			1					none
	1		no money	1	1	aquatab			1					2 months
Ene	1	15000	not needed		1	aquatab				1				none
	1	4000	not needed		1	bleach				1				none
	1	3500	not needed		1	bleach				1				none
			saving		1	bleach				1				none
	1	300	not needed	1	1	each or aquatabs				1				none
	1		not needed		1	aquatab				1				none
			not needed	1	1	bleach				1				none
			not needed							1				none
			not needed	1						1				none
			not needed	1	1	bleach				1				none
			not needed	1	1	cloth filter				1				none
			not needed	1	1	each or aquatabs				1				none
	1		not needed		1	aquatab					1			N/A
			not needed	1	1	bleach					1			N/A
			not needed	1	1	each or aquatabs					1			N/A
			not needed	1	1	aquatab				1				none
			not needed							1				none
			not needed	1	1	bleach				1				none
			not needed							1				none

Appendix D (continued)

	Q4-1							
	Seeds	Animal	Latrine	Soap	Tea	Clothes	Food	Meat
Abdoul-Karim	6	3	2	2	1	3	1	2
	5	4	2	2	1	1	2	3
	4	3	3	2	2	2	2	2
	3	3	2	2	2	2	3	3
	3	3	2	2	2	2	4	2
	3	2	2	3	0	0	10	0
	6	4	1	1	2	1	3	2
	4	4	3	2	2	1	3	1
	4	4	3	1	2	1	3	2
	2	2	2	4	2	3	3	2
	5	2	3	1	2	2	3	2
	2	2	3	2	5	1	4	1
	5	3	3	1	4	1	2	1
	4	2	3	3	2	4	1	1
	3	2	3	3	2	2	2	3
Bama	3	4	2	3	1	3	2	2
	2	2	1	3	3	4	3	2
	3	2	3	3	3	3	3	2
	3	3	4	1	1	2	3	3
	3	3	2	2	2	3	3	2
	5	2	2	2	3	2	2	2
	3	2	2	2	3	3	3	2
	2	3	2	2	2	3	2	4
	7	2	2	2	2	2	2	1
	3	4	3	2	2	2	2	2
	3	3	2	2	2	2	3	3
	3	3	2	2	2	3	3	2
	4	2	1	2	1	3	5	2
	4	3	3	2	2	2	3	1
Biba	4	3	3	5	1	2	1	1
	4	2	4	4	1	2	2	1
	4	4	4	2	1	1	2	2
	5	2	2	2	4	0	2	3
	5	2	1	1	4	2	3	2
	3	5	3	2	1	2	1	3
	4	2	4	2	2	1	3	2
	5	4	3	2	2	1	1	2
	2	2	5	1	3	1	5	1
	6	4	2	3	1	1	1	2
	2	3	4	1	1	4	2	3
	4	3	3	2	3	2	1	2
	3	4	2	3	2	2	2	2
	4	3	2	2	2	2	3	2
	4	3	2	2	2	2	3	2

Appendix D (continued)

	Q4-1							
	Seeds	Animal	Latrine	Soap	Tea	Clothes	Food	Meat
Diaba-Peulh	10	3	1	0.5	1	1	3	0.5
	3	3	2	2	2	3	3	2
	3	5	3	1	3	1	3	1
	4	3	3	1	2	1	5	1
	3	2	5	4	0	2	2	2
	10	1	3	1	2	0.5	1	1.5
	5	2	2	4	1	1	4	1
	4	1	3	2	3	1	5	1
	4	3	2	2	4	3	1	1
	3	3	2	2	3	2	4	1
	3	2	4	3	2	2	3	1
	3	3	2	3	2	2	2	3
	2	2	3	3	1	2	3	4
	3	3	3	2	2	3	3	1
	4	4	2	2	1	3	2	2
Diongue-Bambara	4	2	5	2	1	2	2	2
	5	3	3	2	2	2	1	2
	4	2	3	2	3	2	3	1
	6	4	2	2	0	2	2	2
	2	3	3	5	2	1	1	3
	3	3	3	3	0	3	2	3
	4	3	4	1	2	2	2	2
	5	3	2	2	0	3	3	2
	13	1	1	1	1	1	1	1
	5	3	2	1	2	1	4	2
	4	3	2	3	1	1	3	3
	4	3	3	1	0	3	2	4
	6	2	2	1	1	3	4	1
	3	4	2	2	2	2	3	2
	4	3	4	2	0	4	1	2
Ene	2	2	2	2	2	3	6	1
	5	2	2	2	1	1	5	2
	3	2	3	2	2	2	4	2
	2	3	2	2	2	3	4	2
	2	4	3	2	2	2	3	2
	4	3	2	2	1	4	2	2
	2	2	4	2	2	2	5	1
	4	3	3	2	1	1	5	1
	3	2	4	2	2	3	2	2
	3	3	3	2	2	2	3	2
	2	3	3	2	2	2	5	1
	3	3	2	1	3	1	3	4
	5	3	3	2	2	1	3	1
	10	2	1	1	1	1	2	2
	3	2	2	2	2	3	3	3
	2	3	1	1	2	4	4	3
	3	2	2	2	3	2	3	3
	4	2	3	1	3	2	4	1
	3	2	2	1	2	4	3	3
	10	2	2	1	1	1	1	2

Appendix D (continued)

	Q4-2									
	Tea	Meat	Pagnes	Clothes	Soap	Gas	Granary	Hangar	Rice	Hospital
Abdoul-Karim	1	2	4	x	4	x	x	5	3	x
	1	4	3	x	3	x	x	2	x	5
	2	3	4	x	4	x	x	5	1	x
	3	x	2	x	2	x	x	1	4	5
	1	4	2	x	2	x	x	3	5	x
	1	x	2	x	2	x	x	3	5	4
	4	x	1	3	1	3	x	2	x	5
	1	2	3	x	3	x	x	5	4	x
	1	x	4	x	4	x	3	x	x	2
	1	5	2	x	2	x	x	4	x	3
	2	x	1	4	1	4	x	3	5	x
	x	5	1	2	1	2	x	x	4	3
	2	5	1	x	1	x	x	3	x	4
	2	x	1	3	1	3	4	x	5	x
	3	x	5	x	2	x	x	4	1	2
Bama	1	2	3	4	3	4	x	x	x	5
	1	2	4	x	4	x	x	3	x	5
	2	3	1	x	1	x	x	4	5	x
	3	x	1	5	1	5	x	4	x	2
	x	4	1	5	1	5	3	x	x	2
	1	x	3	x	3	x	x	2	5	4
	1	x	x	4	x	4	2	x	x	3
	x	1	5	x	5	x	2	x	x	4
	1	x	2	x	2	x	4	x	5	3
	x	1	x	4	x	4	x	2	5	3
	1	3	2	x	2	x	5	4	x	x
	1	x	2	3	2	3	x	5	x	4
	1	x	x	3	x	3	2	x	4	x
	x	3	1	5	1	5	x	x	4	x
Biba	2	3	1	4	x	x	5	x	x	x
	2	3	1	4	x	5	x	x	x	x
	3	x	x	5	x	1	2	4	x	x
	1	x	3	4	x	2	5	x	x	x
	1	5	4	x	x	3	2	x	x	x
	1	2	5	3	x	4	x	x	x	x
	1	2	x	3	x	5	x	4	x	x
	1	x	x	x	4	3	5	2	x	x
	1	3	x	5	x	2	x	4	x	x
	2	1	4	x	x	x	5	3	x	x
	1	4	2	x	x	3	x	5	x	x
	1	5	2	x	x	4	3	x	x	x
	1	3	4	x	x	2	5	x	x	x
	1	4	2	x	x	3	5	x	x	x
	2	5	4	3	x	1	x	x	x	x

Appendix D (continued)

Q4-2										
	Tea	Meat	Pagnes	Clothes	Soap	Gas	Granary	Hangar	Rice	Hospital
Diaba-Peulh	2	x	1	x	x	3	5	4	x	x
	1	2	3	x	x	4	5	x	x	x
	3	x	2	x	x	1	5	4	x	x
	3	x	1	5	x	4	x	2	x	x
	3	x	2	x	x	1	5	4	x	x
	3	x	2	x	5	1	x	4	x	x
	3	4	2	x	x	1	5	x	x	x
	2	5	1	x	x	4	x	3	x	x
	1	x	2	x	x	4	5	3	x	x
	1	3	4	5	x	2	x	x	x	x
	2	3	5	x	x	1	x	4	x	x
	x	4	1	x	x	2	5	3	x	x
	1	4	3	x	x	5	x	2	x	x
	1	x	2	x	3	5	4	x	x	x
	1	x	4	5	x	3	x	2	x	x
Diongue-Bambara	3	1	2	x	x	4	x	5	x	x
	2	3	4	x	x	1	x	5	x	x
	2	1	3	x	x	x	5	4	x	x
	1	x	3	x	x	2	5	4	x	x
	1	2	3	5	x	4	x	x	x	x
	1	x	3	x	x	2	5	4	x	x
	1	x	x	3	x	4	5	2	x	x
	1	4	2	x	x	3	5	x	x	x
	4	5	2	3	x	x	1	x	x	x
	1	2	3	x	x	x	5	4	x	x
	1	2	5	x	x	3	4	x	x	x
	1	x	4	x	x	3	5	2	x	x
	x	2	3	x	x	1	4	5	x	x
	1	4	2	x	x	5	x	3	x	x
	1	2	3	x	x	5	x	4	x	x
Ene	1	2	5	4	X	X	5	4	X	X
	1	X	X	2	X	3	X	2	X	3
	1	4	3	X	X	X	3	X	X	X
	1	2	3	x	X	X	3	x	X	X
	1	4	2	x	x	x	2	x	x	x
	x	1	x	4	x	3	x	4	x	3
	1	3	2	5	x	x	2	5	x	x
	1	2	x	5	4	x	x	5	4	x
	1	2	4	x	x	3	4	x	x	3
	1	x	4	5	3	2	4	5	3	2
	1	2	4	5	x	x	4	5	x	x
	4	x	x	1	x	x	x	1	x	x
	5	4	2	x	x	x	2	x	x	x
	2	3	x	x	x	5	x	x	x	5
	1	3	4	x	x	x	4	x	x	x
	x	x	3	x	5	4	3	x	5	4
	3	1	4	x	x	x	4	x	x	x
	1	2	4	x	x	x	4	x	x	x
	2	x	3	x	x	x	3	x	x	x
	1	2	4	3	x	x	4	3	x	x

Appendix D (continued)

Q4-3										
	House	Moto	Fields	Garden	Pump	Latrine	Animal	Work Cow	Panel	Cart
Abdoul-Karim	3	x	1	x	x	4	x	2	x	5
	1	x	2	x	x	4	x	3	x	5
	1	x	2	3	x	x	x	4	x	5
	1	x	2	x	5	3	x	4	x	x
	x	x	1	x	4	3	x	2	x	5
	x	x	x	x	3	2	5	1	x	4
	3	x	2	x	x	x	5	1	x	4
	1	4	2	5	x	x	x	3	x	x
	2	x	1	x	x	3	4	x	x	5
	x	5	x	x	4	x	3	1	x	2
	3	5	1	x	x	x	x	2	x	4
	3	x	1	x	5	x	x	2	x	4
	4	x	1	x	5	x	x	2	x	3
	2	5	3	x	x	x	1	x	x	4
	2	x	3	x	5	1	x	4	x	x
Bama	4	x	1	x	2	x	x	3	x	5
	3	x	2	x	1	5	x	4	x	x
	x	x	1	2	3	x	4	x	5	x
	3	x	1	x	x	x	x	2	5	4
	x	x	4	x	3	5	x	1	x	2
	3	x	1	x	4	x	5	2	x	x
	4	3	x	x	2	x	x	x	5	1
	x	5	2	x	4	x	x	1	x	3
	x	x	1	3	2	5	x	4	x	x
	x	x	1	x	3	x	4	2	x	5
	2	5	3	x	1	x	x	x	x	4
	5	x	3	x	2	x	1	x	x	4
	4	x	1	x	2	x	x	3	x	5
	x	5	1	x	2	3	x	x	x	4
Biba	x	x	x	x	2	3	4	1	x	5
	4	x	3	x	1	2	x	5	x	x
	x	x	2	x	5	4	x	1	x	3
	x	x	1	x	5	4	x	2	x	3
	2	x	1	x	x	x	5	3	x	4
	1	x	x	3	4	5	2	x	x	x
	2	x	1	x	4	x	1	x	x	5
	x	x	1	x	2	5	x	3	x	4
	4	5	1	x	2	x	x	3	x	x
	3	x	2	5	1	4	x	x	x	x
	x	5	2	1	3	4	x	x	x	x
	x	x	2	5	3	x	x	1	4	x
	2	x	x	4	1	3	x	5	x	x
	x	x	1	3	4	x	x	2	x	5
	x	x	1	3	2	4	x	5	x	x

Appendix D (continued)

Q4-3										
	House	Moto	Fields	Garden	Pump	Latrine	Animal	Work Cow	Panel	Cart
Diaba-Peulh	1	3	4	2	x	x	x	x	5	x
	3	x	x	x	1	2	4	x	5	x
	1	x	2	3	x	x	5	4	x	x
	2	x	1	x	4	x	x	3	x	5
	1	x	2	4	x	3	5	x	x	x
	2	x	1	x	x	4	3	x	x	5
	1	x	2	x	x	x	3	4	x	5
	4	x	x	x	1	3	x	2	x	5
	3	x	4	x	x	2	x	1	x	5
	4	x	1	x	x	5	x	3	x	2
	x	x	1	2	x	5	4	3	x	x
	1	x	2	x	4	3	x	5	x	x
	2	x	1	5	x	4	x	3	x	x
	2	x	3	x	1	x	5	4	x	x
	5	x	4	x	2	x	3	1	x	x
Diongue-Bambara	3	x	1	x	x	4	x	2	x	5
	2	x	1	x	3	5	x	4	x	x
	x	x	1	x	x	5	3	2	x	4
	3	x	2	x	1	5	x	4	x	x
	x	5	3	2	x	4	x	1	x	x
	2	x	1	4	x	5	1	3	x	x
	1	x	3	x	2	5	x	4	x	x
	x	x	2	4	5	3	x	1	x	x
	4	5	1	x	x	x	3	2	x	x
	1	x	2	x	x	5	x	3	x	4
	x	x	1	x	5	3	x	2	x	4
	3	5	2	x	x	4	x	1	x	x
	2	x	3	x	x	5	x	1	x	4
	x	x	1	3	x	4	x	2	x	5
	4	x	1	x	x	x	3	2	x	5
Ene	X	X	2	5	1	3	X	4	X	X
	X	X	4	5	1	3	X	2	X	X
	3	5	4	X	X	2	X	1	X	X
	3	x	5	x	4	2	x	1	x	x
	4	x	1	2	3	x	x	x	x	5
	3	5	1	x	2	4	x	x	x	x
	4	5	x	x	3	x	2	x	x	1
	4	x	1	x	3	x	x	2	x	5
	4	x	3	1	2	x	x	x	x	5
	3	x	2	x	1	4	x	5	x	x
	x	x	3	2	1	5	x	4	x	x
	5	x	x	4	1	3	x	x	2	x
	3	x	4	x	1	5	2	x	x	x
	4	5	1	x	x	x	x	2	x	3
	x	x	1	x	3	5	4	2	x	x
	1	x	3	x	4	x	x	2	x	5
	x	x	1	x	3	4	5	2	x	x
	1	x	2	5	3	x	4	x	x	x
	4	x	1	x	3	5	x	2	x	x
	1	x	2	3	4	x	x	x	x	5

Appendix D (continued)

	Q4-4								Q4-5	Q4-5			
	Slab	Pit	T Roof	M Roof	Soak Pit	Manu. Slab	Cement Shelter	Vent Pipe		Pit	Soak Pit	Structure	Soap
Abdoul-Karim	10500	8000	5000	10000	7500	7500	15000	5000		8500	5000	4000	3000
	5000	5500	1000	7000	5000	5000	10000	2500		5000	2000	2000	2500
	13000	12500	7500	13000	7000	8000	25000	3500		10000	3500	5000	4000
	10000	10000	5000	10000	5000	7500	15000	5000		10000	3000	10000	3000
	15000	7500	3000	10000	10000	7500	12500	4000		7500	4000	3000	3000
	10000	10000	10000	10000	10000	15000	20000	5000		10000	2500	10000	1000
	10000	7500	4000	10000	9000	7500	30000	4000		7500	2000	3000	2000
	10000	7500	3500	10000	5000	7500	12500	3500		7500	3000	3500	2500
	5000	5000	1500	7000	5000	5000	10000	2500		5000	2000	2000	2000
	10000	5000	5000	10000	5000	5000	10000	4000		5000	2500	2500	2500
	10000	6000	1000	8000	7500	8000	11000	4000		6000	2500	4000	2500
	6500	5000	2500	7000	5000	6000	10000	3500		5000	2000	3500	2500
	7000	7000	2500	9000	7000	7000	11000	6000		7000	4000	4000	3000
	8000	5000	2500	7000	6500	6000	7500	2500		5000	2000	2000	2000
	5000	5500	1500	7500	6000	7500	11000	2750		5500	2000	1500	2250
Bama	15000	10000	5000	15000	5000	6000	7500	2500		3000	1000	1000	1250
	5000	5000	1500	7000	5000	6000	10000	1000		5000	2000	2500	2000
	13000	10000	3000	8000	6000	6500	13000	3000		6000	2000	2500	2000
	5500	5200	1500	6000	5200	6000	10000	2500		5000	2000	2000	1500
	5000	5000	1000	7000	2000	2000	10000	2500		5000	2000	2000	2000
	7500	6000	1500	7000	5000	6000	10000	2500		5000	2000	2000	2000
	6000	6000	2500	7000	5000	6000	10000	2000		5000	2000	2000	1500
	12000	5000	2000	8000	5500	6500	12000	3500		7000	2000	2000	2000
	10000	10000	1000	7000	5000	6000	10000	2500		5000	2000	2000	2000
	5900	5250	250	300	5000	2500	7000	1500		5000	2000	1500	2000
	5000	5000	1000	5000	5000	5000	10000	1500		5000	2000	2000	2000
	6000	6200	1000	5000	2000	4000	5000	3500		5000	2000	2000	2200
	5000	6000	1500	7500	1000	6000	11000	1500		4000	1000	2000	1250
	5000	5500	1000	7000	5000	6000	10000	2500		5000	2000	2000	2250
Biba	10000	8000	3000	9000	6000	6500	12000	5000		7000	2500	3000	2000
	6500	5000	2500	7500	6000	6000	10000	3500		7500	2500	2500	2000
	6000	6000	1500	7500	6500	6000	10000	3000		6000	2500	2500	2000
	5500	6000	2500	8000	6000	6500	11000	3000		5500	2500	2500	2500
	7500	7000	3500	9000	8000	7500	11000	4000		8500	4000	4000	3000
	7500	15000	2500	10000	7500	8500	12500	15000		10000	4000	5000	2000
	9000	6500	3000	10000	7500	8000	12500	5000		15000	6000	4000	3500
	8000	9000	2500	8500	8000	9000	15000	5000		9000	5000	3500	3000
	6000	5000	500	6000	2500	6000	7500	1000		5000	1000	2000	500
	6500	5500	1000	7000	6500	6000	10500	2500		5000	2000	2000	2000
	8000	5000	1000	7000	5000	6000	10000	2500		5000	2000	2000	2000
	6500	6000	2500	8500	7000	7500	11500	4500		10000	5000	5000	3500
	7500	7500	2500	8000	7500	7500	12500	5000		7000	3000	3000	2500
	5000	5000	2000	7500	6000	7000	11000	3500		5500	3000	3000	2500
	6000	7500	3000	7500	6000	6500	15000	3500		6000	3000	3000	4000

Appendix D (continued)

	Q4-4								Q4-5	Q4-5			
	Slab	Pit	T Roof	M Roof	Soak Pit	Manu. Slab	Cement Shelter	Vent Pipe		Pit	Soak Pit	Structure	Soap
Diaba-Peulh	5500	5000	1000	7000	5000	6000	10000	2500		2500	2000	2000	2000
	8000	5000	1000	7000	5000	6000	10500	2500		5500	2500	2500	1000
	6000	6000	1000	7000	5000	6000	10000	2500		5000	2000	2000	2000
	15000	10000	11000	10000	11000	10000	50000	5000		6000	2000	2500	2000
	10000	5000	1500	5000	1000	5000	10000	1000		5000	2000	1000	2000
	2500	5000	1000	4000	2000	5000	7500	2000		3500	1000	2000	1000
	6000	3000	1000	6000	1500	5000	6500	1000		3000	1000	1000	1000
	10000	10000	5000	12500	10500	7500	12500	5000		8000	5000	5000	3000
	6000	6000	2500	9000	7500	7000	12000	3000		7500	3000	3000	2000
	7500	8000	2000	20000	7500	6500	15000	2500		5000	2000	3500	2000
	15000	10000	3000	12000	7500	7500	15000	6000		15000	4000	7000	3500
	6000	6500	1500	7000	6000	6000	10000	1000		5000	2000	1000	2000
	8000	10000	5000	13000	7500	8000	20000	3500		10000	3000	5000	2000
	6500	10000	2000	8500	1000	7500	12000	5000		5000	2500	2000	2000
	5500	5000	750	7000	5000	6000	10000	3000		7000	2000	2500	2500
Diongue-Bambara	6000	5500	1250	7000	5250	6500	10250	2500		5000	2000	2000	2000
	5500	6250	1250	7250	5500	6000	10500	3250		6250	2000	2500	2500
	3000	4500	1000	5000	4000	3000	10000	1500		5000	500	1000	2000
	5500	3000	1000	2500	1500	3500	2500	1000		1500	300	1000	2000
	5000	5000	1000	6000	5000	4000	5000	1000		2500	1000	2000	1000
	5500	5000	1500	7500	2500	5000	10000	2500		5000	1000	2000	500
	2500	2500	500	2500	1500	2500	5000	1000		2500	500	1000	750
	5500	6000	2000	7000	6500	6500	11000	4000		6000	3000	3000	2500
	13000	6000	1500	2000	7000	7000	11500	5000		7000	4000	5000	1500
	5500	5000	1000	5000	1000	5000	7500	1500		1500	1000	3000	1000
	5750	5000	1750	5000	6000	2500	7500	2500		4000	1500	2000	1000
	6000	7000	2000	9000	7000	6000	13000	3000		6000	2500	2500	2000
	6000	5000	1500	8000	6500	6000	11000	2500		6000	2000	2500	1000
	7000	5500	2000	7500	6000	6500	11000	3000		5500	2500	2500	2500
	6000	6000	1500	7500	5500	6500	11000	3000		6000	2500	2500	2500
Ene	15000	15000	5000	7500	6000	7500	11000	3000		7000	2500	3000	3000
	25000	10000	5000	15000	7500	7500	13000	5000		6500	3000	5000	3000
	7500	7500	2500	8000	5000	7500	10000	4000		6000	2000	2500	2000
	7500	6500	1500	7500	6000	6000	10000	2500		5000	2000	2500	2500
	11000	10000	5000	10000	2500	7500	11000	1500		7500	3000	3000	1000
	10000	10000	1000	10000	6000	6500	10000	3000		5000	2500	2000	2000
	6000	5000	1000	7000	5000	6000	10000	2500		5000	2000	2000	2000
	5000	5000	1000	5000	5000	6000	10000	2500		5000	2000	2000	2000
	7000	7000	1500	7000	7000	6500	10000	3000		7000	2500	3000	2500
	5000	6000	1200	7000	5000	6000	5000	2000		5000	2000	2000	2000
	12000	5000	2000	10000	7000	7000	12000	3000		7000	2000	2000	2500
	10000	12500	5000	10000	7500	6000	10000	3000		7500	2500	2000	3000
	7500	8000	0	7500	6000	5000	1300	2500		8000	3000	2000	2000
	8500	5000	1250	7000	2500	6000	10000	2500		6000	2000	2500	2500
	10000	10000	2500	8000	5000	6000	10000	2500		5000	2000	2000	2500
	7500	7500	1500	5000	2500	6000	5000	1000		2500	1000	1000	1000
	8000	7000	2000	7000	6000	6000	10000	2000		3000	1000	1000	1000
	5000	5000	1000	7000	5000	5000	5000	2500		2500	1000	1000	500
	2500	4000	1000	5000	2500	3000	5000	1000		4000	1000	1000	2000
	10000	8000	3000	10000	6000	7000	13000	4000		8000	3000	2500	2000

Appendix D (continued)

	Q4-6									
	Self Import	Group Local	Self Local	Group Import	Pay	Comm. Slab	Dig Pay	NGO 2/3	Market Slab	NGO Materials
Abdoul-Karim	5	x	x	4	x	1	x	x	2	3
	4	x	x	2	x	5	x	3	x	1
	2	5	x	4	x	3	x	x	x	1
	x	x	x	1	5	2	x	x	4	3
	5	x	2	3	x	x	x	1	4	x
	x	x	x	1	5	3	4	x	x	2
	x	x	2	1	x	3	x	5	x	4
	x	4	5	3	x	2	x	1	x	x
Bama	x	x	5	3	x	4	x	2	x	1
	x	4	x	5	x	3	x	2	x	1
	x	x	5	4	x	2	x	3	x	1
	x	5	4	2	x	x	x	3	x	1
	x	3	x	2	x	4	x	5	x	1
	x	3	5	4	x	2	x	x	x	1
	x	1	x	2	x	4	x	5	x	3
Biba	x	x	5	3	x	4	x	2	x	1
	x	2	x	x	5	3	x	x	4	1
	x	x	5	3	x	x	x	2	4	1
	4	x	x	1	x	2	x	x	5	3
	x	x	x	2	x	3	4	5	x	1
	x	x	x	2	x	3	x	5	4	1
	5	x	x	3	x	4	x	1	x	2

Appendix D (continued)

	Q4-6									
	Self Import	Group Local	Self Local	Group Import	Pay	Comm. Slab	Dig Pay	NGO 2/3	Market Slab	NGO Materials
Diaba-Peulh	4	x	x	2	x	3	x	x	5	1
	x	x	5	x	x	3	x	2	4	1
	x	x	x	1	5	4	x	2	x	3
	x	4	3	x	x	2	x	x	5	1
	x	5	x	4	x	1	x	x	2	3
	x	x	x	1	3	2	x	4	x	5
	1	x	x	2	x	5	x	4	x	3
	x	5	x	1	x	2	3	x	x	4
Diongue-Bambara	x	5	x	3	x	4	x	2	x	1
	x	x	x	2	x	4	3	1	5	x
	x	x	4	2	x	1	5	3	x	x
	x	x	x	2	4	1	5	x	x	3
	x	x	5	2	x	3	x	x	4	1
	5	x	4	1	x	x	x	x	3	2
	x	4	x	3	2	5	x	1	x	x
Ene	X	4	5	X	X	3	X	2	X	1
	3	5	x	1	x	4	x	2	x	x
	x	3	x	1	x	5	x	2	x	4
	x	x	5	1	x	2	x	4	x	3
	x	4	x	3	x	2	x	5	x	1
	x	x	x	1	x	4	x	2	5	3
	x	x	x	3	5	4	x	2	x	1
	x	5	5	2	x	4	3	1	x	x
	x	3	x	2	x	4	x	1	5	x
	x	3	4	2	x	5	x	x	x	1
	x	1	x	3	x	4	x	x	5	2

Appendix D (continued)

	Q4-7									
	Self Import	Group Local	Self Local	Group Import	Pay	Comm. Slab	Dig Pay	NGO 2/3	Market Slab	NGO Materials
Abdoul-Karim										
	x	x	x	3	5	4	x	2	x	1
	5	x	x	2	x	3	x	x	4	1
	3	x	5	4	x	x	x	x	2	1
	x	x	5	3	x	x	x	2	4	1
	x	x	5	1	4	x	x	x	2	3
	5	x	x	2	x	3	x	x	4	1
	x	x	x	5	x	2	x	4	3	1
Bama										
	x	3	4	x	x	5	x	2	x	1
	x	1	5	2	x	x	x	4	x	3
	x	x	5	3	x	2	x	x	4	1
	x	4	5	x	x	1	x	3	x	2
	x	x	5	3	x	4	x	2	x	1
	x	4	x	5	x	3	x	2	x	1
	x	x	5	4	x	3	x	2	x	1
Biba										
	5	x	x	3	x	x	4	2	x	1
	x	x	4	2	x	5	3	x	x	1
	4	x	x	3	5	x	x	2	x	1
	x	x	5	3	x	4	x	2	x	1
	x	x	x	4	x	5	3	x	2	1
	x	1	x	2	x	4	x	x	5	3
	x	x	x	4	x	1	x	2	3	5
	4	x	x	3	x	5	x	2	x	1

Appendix D (continued)

	Q4-7									
	Self Import	Group Local	Self Local	Group Import	Pay	Comm. Slab	Dig Pay	NGO 2/3	Market Slab	NGO Materials
Diaba-Peulh	x	4	x	5	x	3	x	2	x	1
	x	5	x	4	x	2	x	x	3	1
	x	1	2	x	x	5	x	x	x	4
	x	x	x	1	5	2	x	4	x	3
	x	x	x	1	x	3	x	4	5	2
	x	x	x	2	x	4	x	1	5	3
	2	4	x	1	x	3	x	x	5	x
Diongue-Bambara	x	x	x	2	x	1	x	3	5	4
	x	x	5	4	x	3	x	1	x	2
	x	x	3	5	x	x	x	2	4	1
	x	2	4	5	x	3	x	x	x	1
	x	x	4	3	x	2	x	x	5	1
	x	x	5	4	x	2	x	x	3	1
	x	x	5	4	x	3	x	2	x	1
	x	x	x	5	x	2	x	3	4	1
Ene	X	2	3	X	X	4	5	1	X	X
	X	x	4	3	x	x	x	2	5	1
	x	x	x	4	x	5	x	3	2	1
	x	x	x	4	x	2	x	3	5	1
	x	5	x	4	x	2	x	3	x	1
	5	x	x	1	x	4	x	3	x	2
	x	4	x	5	x	2	x	3	x	1
	x	2	3	x	x	4	x	5	x	1
	x	4	5	x	x	2	x	3	x	1



Appendix D (continued)

	Q4-8								
	Money	Embarrassed	Dangers	Social	Unsanitary	Behavior	Build	Unsafe	No Need
Diaba-Peulh	0	0	1	1	1	1	0	0	0
	0	0	1	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	1
	0	0	1	0	0	0	0	0	0
	1	0	1	0	0	1	0	0	0
	1	0	1	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	0
	0	0	1	0	0	1	0	0	0
	1	0	0	0	0	0	0	0	1
	0	0	1	1	0	0	0	0	0
	1	0	1	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	0
	1	0	1	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	0
	1	0	1	0	0	1	0	0	0
	0	0	1	0	0	1	0	0	1
	1	0	1	0	1	0	0	0	0
Diongue-Bambara	0	0	0	0	0	1	0	0	0
	1	0	0	0	0	1	0	0	0
	1	0	1	0	0	0	0	0	0
	0	0	0	0	0	1	0	0	0
	0	0	1	0	0	0	0	0	1
	0	0	1	0	0	1	0	0	0
	0	0	1	0	0	0	0	0	1
	0	0	0	0	0	1	0	0	1
	0	0	0	0	0	0	1	0	1
	0	0	1	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	1
	1	0	1	0	0	0	0	0	0
Ene	0	0	1	0	0	1	0	0	1
	0	0	0	0	0	1	0	0	1
	1	0	0	0	0	0	0	0	1
	1	0	0	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0
	1	0	1	0	0	0	0	0	1
	0	0	1	0	0	1	0	0	0
	0	0	1	0	0	0	0	0	1
	0	0	1	0	0	0	0	0	1
	1	0	0	0	0	0	0	0	0
	1	0	1	0	0	1	0	0	0
	0	0	1	0	0	1	0	0	1
	0	0	0	0	0	1	0	0	0
	0	1	0	0	0	0	0	0	0
	0	0	1	0	0	1	0	0	1
	0	0	0	0	0	1	0	0	0
	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0

## **About the Author**

Justin V. Meeks is a Peace Corps Master's International student in the Department of Civil and Environmental Engineering at the University of South Florida. He holds a Bachelor of Science degree in Civil Engineering from Gonzaga University, which he received in May, 2008. Justin is a licensed Engineering-in-Training (EIT) in the state of Washington. While at Gonzaga, Justin was part of a project team that received Honorable Mention at the Environmental Protection Agency's (EPA) 5<sup>th</sup> Annual P3 – People, Planet, Prosperity Conference, for their project “West African Technology, Education, Reciprocity (WATER) for Benin”. With this project, Justin and a team of multidisciplinary students traveled to Benin, Africa in August, 2007 to set up a ceramic water filter manufacturing facility and water quality testing laboratory. Justin and part of the team continued this project during his last year at Gonzaga by prototyping a carbon activation system utilizing waste materials as a carbon source and researching alternative fuel sources for the firing of the ceramic filters and heat source for the carbon activator. Justin was most recently employed as a Peace Corps Volunteer in Mali, West Africa, where he worked as a Water and Sanitation Engineer from July, 2009 to November, 2011. While in Mali, Justin worked on projects to start a gardener's cooperative and a water and sanitation committee in his host community. As part of the start-up operations of the cooperative, he helped to design and build a storage facility for the group. As a Master's International student his research interests are sustainable water and sanitation development, behavior change, and community-led total sanitation (CLTS).