



**Miller Center**  
for Social Entrepreneurship



# Banka Bio Impact Assessment



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# EXECUTIVE SUMMARY

Open defecation is an extremely pressing issue across India with approximately 520 million people reportedly practicing open defecation in 2015. To fulfill its vision of providing access to safe sanitation services, Banka Bio recently completed a project where they installed 3,153 bio-toilets across the state of Goa. After completing this project, Banka Bio hoped to understand what impact the installation of toilets had on the public health outcomes and well-being of families and individuals.

Through meetings with Sanjay and Namita Banka as well as numerous Banka Bio employees, we gained a deeper understanding of the sanitation crisis that exists across India. We recognized how the lack of access to sanitation facilities affects overall mental and physical well-being, especially for women. Over the following 2 months, we developed and optimized a survey to assess the impact of the recently installed bio-toilets on customers and find areas of improvement for Banka Bio. The survey allowed us to measure three aspects of bio-toilet impact: bio-toilet experience, changes in health, and changes in personal and social well-being.

The survey was deployed to 52 individuals across 6 villages with the help of a local researcher. After gathering and analyzing the survey data we discovered three main findings:

1. Bio-toilet installation leads to increased health and healthy habits
2. Customers experience an improved quality of life since bio-toilet installation
3. Women in particular are positively impacted by bio-toilet installation

These three findings are the core of this deliverable.

We have also laid out recommendations for Banka Bio based on our experience completing this project and the feedback we received from customers. These recommendations outline the need for continuous future administration of the survey as well as updates to be made to the bio-toilet based on customer experience. By acting on these recommendations, Banka Bio will be better equipped to serve their customers. Understanding and presenting the impact of their bio-toilets will lead to future funding that allows Banka Bio to scale up and expand their projects thus furthering positive health outcomes and the well-being of communities across India.

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# Overview

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India faces a lack of facilities, specifically toilets, contributing to inequality of access to WaSH (water, sanitation, and hygiene). Banka Bio addresses the absence of adequate sanitation services across India by providing sanitation infrastructure including biodigesters to improve human waste management solutions. While working with Banka Bio, our challenge was to quantify and describe the cumulative, positive social impact of bio-loos for families in Goa.



**Figure 1:** Customer in front of Banka Bio bio-toilet.

(Photo Credit: Banka Bio)



**Figure 2:** Banka Bio installed public bio-toilets.

(Photo Credit: Banka Bio)

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# Statement of Problem

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Open defecation is an extremely pressing public health issue especially in rural India. There were, reportedly, approximately 520 million people practicing open defecation in India in 2015. The vast majority of these people live in rural areas where toilet ownership rates are low due to various factors (Jain et al., 2020). Open defecation is such a pressing issue due to the heightened levels of disease transmission and mortality as the waste contaminates water sources and is easily transmittable orally.

The practice of open defecation and the overall lack of sanitation facilities in rural India causes about 100,000 tons of human feces to be found in the open per day. The concentration of human feces per square kilometer is highest in India and double to world average. This high level of open defecation leads to high rates of disease among the population (Banerjee et. al., 2017). These diseases come from exposure to fecal pathogens from water or simple oral transmission and cause intestinal worms and diarrhea. Disease outcomes include lack of appetite, lowered immunity, lowered adsorption of nutrients, and ultimately malnutrition (Rahman et al., 2020).

Women and girls are also greatly impacted, not only by the diseases that come from open defecation, but by the safety risks open defecation presents. When women are forced to defecate in the open, there is an eminent loss of dignity and privacy. When defecating in the open, women are at risk for sexual assault and violence as they must travel away from the home to find a hidden area. A study found that the risk of sexual violence increased 40% for women who practiced open defecation compared to those who had a toilet (Saleem et al., 2019).

Open defecation exposes women to these threats as they are forced to endure traveling to remote locations while it is dark out. Additionally, women suffer psychologically as they have expressed the fear of being watched or intruded on which causes a loss of dignity overall (Saleem et al., 2019). These stressors can be mitigated through the installation of toilets in or near homes for women and girls to use.

In 2014 the Indian government began a mission to end open defecation, especially in rural areas. The program, Swachh Bharat Abhiyan, intended to make India open defecation free by October 2019. To do so, the government focused on changing behaviors by communicating through advertisements using popular figures. The government also worked to change behaviors by providing subsidies for families to build latrines in rural areas. However, these subsidies were not effective as the toilets built with them often went unused and did not meet the needs of users (Jain, et. al., 2020).

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Users of the government funded toilets expressed their issues with the toilet design. First, users explained the issue of water scarcity in their villages. The subsidized toilets required 10-15 liters of water for flushing which was extremely difficult to obtain multiple times a day as there is limited water available throughout rural India (Mac, 2018). Second, users complained about the depth of the pit. The government funded toilets were only 3 feet deep and families worried it would fill too quickly (Mac, 2018). Lastly, users expressed their desire to have adequate lighting and ventilation for toilets. A main issue was the pit toilets producing an odor that spread throughout the house (Mac, 2018). An optimal toilet, therefore, would not need emptying or cleaning, would not require much water for flushing, and would not produce a foul odor. Hence, Banka Bio began to address these issues in their bio-toilet design.

Banka Bio uses biodigesters designed by the Defense Research and Development Organization (DRDO) to combat the issues brought about by government funded toilets. This biodigester sits below the squatting toilet to digest the waste through anaerobic digestion. Anaerobic digestion is a biological process that utilizes bacterial and archeal populations to break down organic matter without the need for oxygen. Through this process methane and carbon dioxide are produced which together are termed biogas (Roopnarain, et. al. 2021).

The customer was at the forefront of thought when designing this product. The DRDO claims this biodigester is “odorless, free from pathogens, and does not create any aesthetic nuisance” (Sekhar et al., 2016). There is also no need to transport any waste as the effluent and gas can be released on scene (Sekhar et al., 2016). The effluent may also be used for agricultural purposes while the biogas could be used for energy. Overall, this design is becoming more popular throughout India as it addresses the needs of the community.

Banka Bio uses this design to fulfill their aim of providing functioning bio-toilets where facilities are rare in the most cost-effective and sustainable manner. Banka Bio manufactures these biodigesters for installation on site for schools, hospitals, residential buildings, hotels, and more so that waste is properly managed on-site and meets the needs of customers.

In one of their latest projects, Banka Bio installed 3,153 toilets throughout the state of Goa. The Indian government spearheaded this project as a part of the push to stop open defecation and employed Banka Bio to help. Thousands of people across the state of Goa applied to have a toilet installed at their home and Banka Bio was given a portion of these locations to install their bio-toilets. This project recently finished in April, 2022. This project was one of the largest Banka Bio has ever done.

With the project’s completion, Banka Bio asked us to survey the effects of installation on the health and well-being of customers. The survey and results could be used to understand the impacts of Banka Bio’s work and leverage those outcomes to get investors to fund additional projects.

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# Survey Design

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Banka Bio approached the Miller Center looking for insight into the impact of toilet installation on positive public health outcomes and increased overall well-being, specifically for women and children. We studied the impact of bio-toilets on families and individuals through distributing surveys to local customers. All of the gathered data was then organized and analyzed to create a substantial, persuasive argument clearly describing Banka Bio's impact.

Before designing the survey, we met with Banka Bio project managers and government officials involved in the Swachh Bharat Abhiyan program. The meetings with project managers provided background information on Banka Bio's recent Goa project and the social enterprise's overall goals. We learned that although COVID affected the installation rate of bio-toilets in Goa, Banka Bio continued to work with the government throughout lockdown and complete installations in the field, meaning they stayed on track for completion. They mentioned that the Goa project could be an important opportunity for assessing Banka Bio's social impact because it is a small location with lots of recent installations. Banka Bio project managers repeatedly emphasized their goal of including women's voices and limiting gender discrimination through installation of these sanitation systems, which was later incorporated into the survey.

In meeting with government officials, we learned more about the Swachh Bharat Abhiyan program. Banka Bio applied to be a part of the government bio-toilet installation project. There were certain limits set in place by the government for the program, but most technical aspects were left up to Banka Bio, such as the biodigester design. We learned that individual customers completed an application to receive a government installed bio-toilet. From there, the government distributed the customers to 5 various bio-toilet companies, one of these being Banka Bio. The companies would then go forth and complete installations. This meeting provided us key information such as government oversight and customer applications. This information contributed to later survey creation through questions on why customers applied for bio-toilets and what they wanted to change.

After these meetings, we developed the survey to learn about how customers' lives changed after installation. We assessed three aspects of life: public health and infectious disease rates, personal well-being, and the perceived value of the bio-toilet. Customers were also able to submit general feedback as well as any specific issues they've had with their bio-toilet by writing in responses at two points throughout the survey. We then compiled the received data to formulate an impact report showing the benefits of bio-toilet access.

By providing Banka Bio with a cumulative impact report, a repeatable surveying method, and recommendations from customers, we hope to increase their ability to gain the support of funders and investors. After doing so, Banka Bio aims to scale up and provide bio-toilets to customers across India, thus improving public health and well-being.

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# Methods

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## 1. Methodological Approach & Rationale for Questions

We developed an in-depth anonymous survey focused on the impact of bio-toilets on customers, resulting in five overarching categories: Background, Social Benefit, Personal Benefit, Bio-toilet Experience, and Health.

A complete list of survey questions for Banka Bio is seen in Appendix A. Each question is followed by a brief rationale for the measures that may be derived from the responses.

When possible, the survey incorporated the Likert scale, which allows individuals to express how much they agree or disagree with a particular statement. We created a five point scale with options including “strongly disagree,” “disagree,” “neutral,” “agree,” and “strongly agree.” We then transformed this data to a numerical scale of 1-5 by pairing “strongly disagree”=1 to “strongly agree”=5. This quantitative data allowed us to note the magnitude and directionality of responses. We bundled respondents who selected “strongly agree”/“agree”, and respondents who selected “strongly disagree”/“disagree”. This resulted in three categories: Agree, Neutral, Disagree. This method of surveying captured the diversity of responses among customers in Goa.

## 2. Field Testing of the Survey

After reviewing possible data collection methods, we determined that surveying a wide array of customers from various areas and backgrounds would be best suited for the goal of creating a cumulative impact report. Whenever possible, we used Likert scales to measure the attitudes and changes of behaviors the bio-toilets induced. The survey was edited and improved upon numerous times with the help of Dr. Michele Parker, a professor in the Santa Clara University Department of Public Health. Through this iterative process, we grew confident that the final version of the survey would capture the most pertinent information necessary to understand the relevant impact of the bio-toilets.

Since we could not travel to Goa due to COVID-19 restrictions, we hired a local on-the-ground researcher. With the help of Banka Bio, we received applications for the position, held formal interviews with candidates, and vetted the local researcher for any inherent biases. Upon hire, the on-the-ground researcher reviewed the survey. They provided valuable feedback regarding the verbiage and connotation of the proposed questions, thus improving cultural sensitivity and communication between ourselves and the customers.

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Once the finalized survey was complete, we attempted to administer it online via Kobo Toolbox. Banka Bio provided us with the contact information for a portion of the customers (n=150). We sent a link to the survey along with a message introducing ourselves as shown below via WhatsApp.

“Hello,  
My name is [name of the fellow]. I am a student at Santa Clara University in California, USA.  
I am doing research with Banka Bio to collect data and feedback on the bio-toilets they installed in Goa, India.  
Attached is a link to an anonymous, quick 10 minute survey. Please complete this by September 18th, and have other members of your household complete it as well. [Link]”

We were unable to capture survey responses using this method. This is likely due to increasing numbers of online phishing attempts. The customers received a message from unknown numbers outside of the country with no prior notification. Customers may have suspected the message was malicious and avoided all interaction, therefore not responding or completing the survey. Because of the lack of responses, we pivoted and found another delivery method.

After discussing options, it was decided that physical, paper copies of the survey could be administered with the help of the on-the-ground researcher. Using the geotagged location information provided by Banka Bio, the researcher would go door-to-door to issue the surveys, visiting a total of five different villages across the state of Goa. Because the survey was written and printed in English, the researcher aided in translating the survey to respondents and ensuring the questions were understood. The responses were then photographed and sent back to us for analysis.

While analyzing the data, an unexpected methodological problem presented itself. The majority of respondents owned a bio-toilet prior to Banka Bio’s installation. This was problematic because our goal was determining how bio-toilet installation affected open defecation practices. We hoped to receive responses from first time bio-toilet customers to see if an individual’s open defecation practices changed upon bio-toilet installation. Unfortunately, we did not receive many responses from our target customer population. We incorrectly assumed that most respondents applying for the government issued bio-toilets would be receiving their first bio-toilet. Due to this assumption, we did not screen respondents prior to survey administration for previous toilet ownership. Now, as we have understood this methodological problem in our research, we recommend that future administration of this survey specifically targets customers who have had no prior bio-toilets installed. Screening prior to survey administration would confirm whether customers have received a previous bio-toilet or not. This will help clarify how first time bio-toilet installation affects customers and open defecation practices.

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### 3. Conclusions and Implications

The goal of this survey was to provide Banka Bio with a repeatable measuring tool that quantifies the positive impact of bio-toilets for customers, through personal and social benefit, bio-toilet experience, and health.

The survey allows Banka Bio to assess their impact on customers yearly, building up a database of bio-toilet impact and experiences.

This will allow Banka Bio to:

- Describe their impact through quantifiable, numerical impact data
- Visualize changes in customer satisfaction or benefits year to year
- Develop closer relationship to customers overall
- Provide impact data to investors allowing them to continue and expand their work to improve public health and well-being

We are excited to provide this survey to Banka Bio and hope this model creates an opportunity for continual assessment of Banka Bio's impact.

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# Findings

## 1. Bio-toilet installation leads to increased health and healthy habits

Customers were asked a series of questions regarding how their health status and practices have changed since bio-toilet installation. Specifically, customers answered questions regarding changes in their open defecation practices since bio-toilet installation. It can be concluded from these questions that open defecation decreases due to bio-toilet installation. Across all survey responses, 72% (n=50) agree that open defecation decreased in their village due to Banka Bio's in-home bio-toilet installation.

However, an interesting split in the data can be seen when considering two categories: those who owned a toilet prior to Banka Bio's bio-toilet installation and those who did not previously own a toilet. Among respondents who did not own a toilet before Banka Bio's installation, 77% of customers (n=13) agree that the installation decreased their own open defecation practices. This compares to a slim 18% of previous toilet owner respondents (n=33) who agree the installation decreased their own open defecation practices.

### Percentage of respondents who agreed that their open defecation practices have decreased since bio-toilet installation:



These results highlight the impact bio-toilets have on first-time toilet owners. One of the main barriers to stopping open defecation is the lack of access to toilets. By having an at-home toilet and decreasing rates of open defecation in villages, Banka Bio's toilets improve the overall health of customers.

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Customers were also asked about the change in their overall quality of health. Based on the survey responses, it was concluded that the health of customers who did not previously own a toilet improved upon bio-toilet installation.

Among respondents who did not own a toilet before Banka Bio's installation, 73% (n=15) agree that the bio-toilet installation improved their personal health. In contrast, of those who did own a toilet prior to Banka Bio's, only 26% (n=35) agree that the bio-toilet installation improved their personal health.

**Percentage of respondents who agree that the bio-toilet installation improved their personal health:**



When looking at the health of families as a whole, the same trend can be seen. Of those who did not previously own a toilet and received their first toilet through Banka Bio, 67% (n=15) report improved health of their family. However, only 26% (n=35) of previous toilet owners report the same.

Taking into account this data, there is a trend showing greater health improvements for those who did not previously own a toilet. Going forward, Banka Bio should focus efforts on surveying customers who did not previously own a toilet. By excluding those who have owned a toilet before, the direct impact on lowering open defecation rates and, consequently, improving public health, will be more apparent.

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## 2. Customers experience an improved quality of life since bio-toilet installation

The survey examined changes in the customer's personal life since bio-toilet installation. Specific factors that were asked about in this section include feelings of happiness, stress, safety, and worry. Based on the customer's answers it can be concluded that respondents experience an overall increase in their quality of life due to bio-toilet installation. In fact, overall, 95% of respondents (n = 46) agree that their overall quality of life has improved since bio-toilet installation. Of that, 100% of respondents (n = 13) who have not owned a toilet before and 94% of respondents (n = 33) who have owned a toilet before agree. The data shows that overall quality of life improved with the new bio-toilet, regardless of previous bio-toilet installations.

**95%** respondents agree that their overall quality of life improved since bio-toilet installation

Breaking the results down further, customers report positive trends in the metrics of feelings of safety, stress, confidence, and happiness. Among all respondents, 95% (n = 46) agree that they are less worried about their personal safety since bio-toilet installation. Additionally, 89% of respondents (n = 46) agree that they are less stressed since their bio-toilet installation. Since customers now have an accessible, private, at home toilet, there is no need to travel far from home and risk one's safety to openly defecate. These findings support existing data on the dangers of open defecation to personal safety and dignity and highlight bio-toilet access as an important factor for improving the problem. By installing and having access to a bio-toilet, customers experience decreased threats to their personal and sexual safety as well as their personal and sexual dignity.

The data was then examined in terms of those who did own a toilet previously and those who did not. Of those who did not previously own a toilet, 92% (n = 13) agree that they have increased confidence since bio-toilet installation. Lastly, 100% (n = 13) of those who did not previously own a toilet report their family being happier since bio-toilet installation. Once again, as seen in the first finding, those who did not previously own a toilet experience a greater positive personal benefit than those who did own a toilet before Banka Bio's.

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### 3. Women in particular are positively impacted by bio-toilet installation

The "Social Benefit" section of the survey focused on the impact the bio-toilets have had on women in particular. Women were given a specific focus due to the fact that they experience higher rates of sexual violence and harrasment, as well as the loss of dignity when having to defecate in the open. Having an at-home bio-toilet eliminates the need to defecate openly and therefore increases feelings of safety. Overall, 100% of respondents (n = 46) report that women in their household feel safe and less scared when using this bio-toilet. Furthermore, of those who have not previously owned a toilet, 84% of respondents (n = 13) agree that women in their family have more dignity since bio-toilet installation. Women are able to use the toilet alone without the fear of being vulnerable in the open at all hours of the day and night. Banka Bio provides a sense of privacy with their bio-toilets which brings about feelings of empowerment, confidence, and overall dignity for women customers.

#### Impact of bio-toilets on women



Increased  
Safety



Decreased  
Stress



Increased  
Empowerment



Increased  
dignity

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#### 4. Customer Feedback

Respondents were asked to provide feedback on their bio-toilet at two points throughout the survey. First, they were asked if they've experienced issues with their bio-toilet. Later, they were prompted for any additional feedback for Banka Bio. In these sections customers report problems with cleaning their bio-toilet. Some concerns about bio-toilet maintenance include:

**"In open defecation, there was no problem of cleaning.  
If I don't clean the bio-toilet it starts to stink"**

**"Slightly smells occasionally and cleaning becomes a  
problem"**

**"Water does not go fast while cleaning/flushing.  
Therefore we have to wait, time gets wasted"**

Another common theme seen in the feedback from customers was issues with the design of the bio-toilet. Customers report that the door does not function properly and a gap remains when the door is closed. One customer writes "Door- when closed, kind of a gap remains. It feels uncomfortable because of that as from the gap one can peep inside." The gap in the door causes the bio-toilet to feel less private and makes customers worry about using it.

Many customers also report that the bio-toilet stall was too small and could be expanded. Comments such as, "Should be more spacious", "I have sitting issues since I am old. More space should be provided", and "Space is less inside. More space can be made" were made when surveying. Since space is not an issue with open defecation, customers who are using a toilet at home for the first time may be alarmed by this lack of space and opt to continue openly defecating instead. Making the area more spacious is essential to providing comfort and ensuring customers use the bio-toilet.

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# Recommendations

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Based on our research and experience with Banka Bio, we offer a few recommendations for Banka Bio's consideration on future projects.

## 1. Suggested Administration

Administration of the survey to customers after installation would allow Banka Bio to measure noticeable impacts in the lives of customers due to the bio-toilet. For Banka Bio to get a reliable understanding of their target population, they should collect responses from customers who did not previously own a toilet. This will allow them to access and analyze the direct impact of their bio-toilets. Banka Bio should continue to administer the survey to all future customers. We recommend the survey is given to customers one year after receiving the bio-toilet so there is time for customers' experiences and behaviors to change.

We suggest that when customers are selected to receive a bio-toilet, Banka Bio notifies them of the surveying process. The customers should consent to being contacted for a survey and provide their contact information, including address and phone number.

Face-to-face administration is recommended since response rates are higher than web-based surveying and more detailed explanation can be provided in the face-to-face setting. If web-based surveys are used, we suggest notifying all customers that they will be receiving messages with the link to the survey prior to sending it. The link should be provided in a consistent manner using a single web-based survey service. The questions may need to be edited depending on the compatibility of the survey application to make it more user friendly.

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## 2. Customer Feedback

Based on the Impact Survey, we suggest that maintenance policies and the design of the bio-toilet be updated to fit the needs and desires of the customers. The most common suggestions made by the customers include:

### A. Maintenance Issues

Though the bio-toilets are designed to be maintenance free, Banka Bio could instruct customers on best bio-toilet care and cleaning practices during the time of installation. This could help Banka Bio's customers feel confident in their own bio-toilet experience.

Some bio-toilets develop an unpleasant smell at times. This could be due to the cleaning concerns mentioned above, or potentially incorrect use of the bio-toilet. Banka Bio may gain more insight about this problem through interactions or visits to local customers. More research on why the bio-toilets develop an unpleasant smell might be needed. From there, Banka Bio can provide customers a list of tips to avoid smell altogether when the bio-toilets are installed.

Bio-toilet customers report concerns about slow water when flushing the toilet. Based on these responses, we advise Banka Bio to clearly instruct customers on best flushing practices.

### B. Design Updates

Since some customers feel uncomfortable by the gap in the door, they may be less likely to use the bio-toilet. By fixing the issue with the door, the bio-toilet experience of customers would improve and customers may be more inclined to continue using the bio-toilet.

The recommended increase in space could also improve the bio-toilet experience. Increasing the size of the stall would make using the bio-toilet more comfortable for users. Increased comfort would lead to increased usage and positive experiences associated with the bio-toilet.

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# Conclusion

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We are pleased to provide Banka Bio with both the findings and recommendations from their recently deployed survey as well as the survey questionnaire template.

The deployed survey successfully resulted in 3 main findings:

1. Bio-toilet installation leads to increased health and healthy habits
2. Customers experience an improved quality of life since bio-toilet installation
3. Women in particular are positively impacted by bio-toilet installation

Within each of these findings, Banka Bio can see the quantified social impact of the installed bio-toilets on their customer population. Through this data, Banka Bio can also feel confident in their mission of making true impact with their installed bio-toilets.

The deployed survey additionally provided insightful customer feedback in the following categories:

1. Maintenance Issues
2. Design Updates

With these recommendations, Banka Bio can better understand potential customer complaints. They can enact policy or design changes as necessary to address the needs of their customers.

We are also delighted to present the actual survey questionnaire template to Banka Bio.

With this survey, Banka Bio may continue using the survey for continuous future administration. This will allow Banka Bio to obtain yearly quantified data on the positive social impact outcomes of their products, including information about changes in health outcomes, personal and social well-being, and in the bio-toilet experience.

The continuous survey will help Banka Bio continue to quantify and assess the social impact of bio-toilet installation on individuals and communities. By quantifying their social impact over time, Banka Bio will obtain future funding that leads to scaling up and expanding their projects, thus furthering positive outcomes and the well-being of communities.

Through bio-toilet installation, Banka Bio significantly impacts families and individuals living in the state of Goa through positive public health outcomes and increased overall well-being.

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# APPENDICES

## APPENDIX A - CUSTOMER IMPACT SURVEY

### Section 1: Background Information

#### Question 1

Are you male or female?

Rationale: This is a general background question. The purpose of this is to determine gender to generate male versus female results from the data collected. By sorting the data by gender, Banka Bio will be able to measure any potential gender differences in the benefit provided by bio-toilets. For example, Banka Bio may find that females benefit more from bio-toilets than males.

#### Question 2

How old are you?

Rationale: This is a general background question. This question will determine if age is a factor that determines the degree of social benefit provided by bio-toilet use. For example, Banka Bio may find that younger or older respondents derive more benefits from the bio-toilet use.

#### Question 3

What village do you live in?

Rationale: This is a general background question. The purpose of this question is to determine if residents of different villages experience different levels of social benefit from bio-toilet use. The question could also be reworded as a state-level measurement tool to capture variation across broader populations.

#### Question 4

What is your marital status?

Rationale: This is a general background question. The purpose of this question is to determine marital status across two broad categories: single and married/partnered. The goal is to analyze data regarding current marital status. Single accounts for never married, divorced, or widowed/widower. Married/partnered accounts for married, remarried, or living with a partner. This question lets Banka Bio measure potential variation between single and partnered bio-toilet users.

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### **Question 5**

How much schooling do you have?

Rationale: This is a general background question. The purpose of this question is to determine if the educational background of customers is associated with benefit of bio-toilet usage. For example, Banka Bio may find that those with more or less education experience different levels of social benefit from bio-toilet use.

### **Question 6**

When was your bio-toilet installed?

Rationale: This is a general background question. The purpose of this question is to determine if residents with the same year of bio-toilet installation experience similar levels of social benefit from bio-toilet use. For example, if bio-toilets installed in 2019 result in greater social benefit than those installed in 2022, Banka Bio may determine that the difference is due to the extended time period with an installed bio-toilet.

### **Question 7**

Did your household have a toilet before this bio-toilet?

Rationale: This is a general background question. The purpose of this question is to determine if residents who have owned previous bio-toilets experience the same social benefits compared to those who have not. This data can be used by Banka Bio to understand why some customers experience higher levels of social benefit than others. Additionally, this data can help Banka Bio reach a specific audience that will benefit most from bio-toilets.

### **Question 8**

What was your main reason for getting this bio-toilet?

Rationale: This is a multiple choice general background question. The purpose of this question is to determine if residents understand the importance of bio-toilets in terms of sanitation and health. For example, if residents did not select “better sanitation for yourself and family” as a main reason, Banka Bio may use this data to educate their audience and spread awareness about the link between sanitation and health.

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## Section 2: Bio-Toilet Experience

### Question 9

Please describe your bio-toilet experience:

	Strongly Agree	Agree	Neutral / No change	Disagree	Strongly Disagree
I was excited to get my bio-toilet.	5	4	3	2	1
I received good instructions during the bio-toilet installation.	5	4	3	2	1
I use my bio-toilet while I am at home.	5	4	3	2	1
I would replace my bio-toilet if it broke.	5	4	3	2	1
I am satisfied with my bio-toilet.	5	4	3	2	1
The outside of my bio-toilet looks how I want it.	5	4	3	2	1
The inside of my bio-toilet looks how I want it.	5	4	3	2	1
My bio-toilet is easy to use.	5	4	3	2	1
My bio-toilet is quiet.	5	4	3	2	1
My bio-toilet does not smell.	5	4	3	2	1
My bio-toilet feels private.	5	4	3	2	1
My bio-toilet is important to me.	5	4	3	2	1

Rationale: This Likert scale question focuses on bio-toilet experience. This question lets customers express their level of agreeance towards a statement on a scale of “strongly agree”/5 to “strongly disagree”/1. This information will give insight on customer experience and may point out potential recommendations for bio-toilet design updates. For example, if a large percentage of customers select “disagree” or “strongly disagree” for the statement “My bio-toilet does not smell,” Banka Bio may use this data to design bio-toilets with increased air filtration systems.

Prepared by:

### **Question 10**

Is your bio-toilet space used for anything else?

Rationale: This free answer question focuses on bio-toilet experience. The purpose of this question is to determine if residents are using the bio-toilet space as intended or for other reasons such as storage. This data could help Banka Bio gain insight on whether customers are receiving a product that meets their needs.

### **Question 11**

What changes have you made to your bio-toilet?

Rationale: This free answer question focuses on bio-toilet experience. The purpose of this question is to determine if residents are personalizing or updating their installed bio-toilet spaces for their individual needs. This data could help Banka Bio gain insight on what design modifications could be most beneficial to their future customers.

### **Question 12**

What issues have you had with your bio-toilet?

Rationale: This free answer question focuses on bio-toilet experience. The purpose of this question is to let customers specifically note their individual problems with their installed bio-toilet. This data will help Banka Bio gain insight on any recurring problems with design, function, or installation of bio-toilets.

Prepared by:



### Section 3: Health

#### Question 13

Please describe how this bio-toilet has affected you and your family (Circle a number for each given statement).

	Strongly Agree	Agree	Neutral / No change	Disagree	Strongly Disagree
My bio-toilet has improved my health.	5	4	3	2	1
My bio-toilet has improved the health of my family.	5	4	3	2	1
Since having my bio-toilet, my family members have had LESS upset stomachs (including but not limited to diarrhea, nausea/vomiting, stomach cramps, and fever).	5	4	3	2	1
Since having my bio-toilet, my family members have been diagnosed with LESS cholera and infectious diarrheal diseases.	5	4	3	2	1
My bio-toilet has decreased my open defecation practices (skip if no open defecation).	5	4	3	2	1

Rationale: This Likert scale question focuses on the health of customers and their families. Customers express their level of agreeance towards a statement on a scale of “strongly agree”/5 to “strongly disagree”/1. The statements are designed to give insight on personal or familial health trends. For example, if a large percentage of customers select “agree” or “strongly agree” for the statement “My bio-toilet has improved my health,” Banka Bio has data demonstrating that bio-toilet installation leads to better personal health.

Prepared by:



### Question 14

Please describe how these bio-toilets have affected the health of others (Circle a number for each given statement).

	Strongly Agree	Agree	Neutral / No change	Disagree	Strongly Disagree
The bio-toilets have improved the health of my village's children.	5	4	3	2	1
The bio-toilets have improved the health of my village's elderly.	5	4	3	2	1
Since having bio-toilets, people in my village have LESS upset stomachs (including but not limited to diarrhea, nausea/vomiting, stomach cramps, and fever).	5	4	3	2	1
Since having bio-toilets, people in my village have been diagnosed LESS with cholera and infectious diarrheal diseases.	5	4	3	2	1
The bio-toilets have decreased open defecation in my village.	5	4	3	2	1

Rationale: This Likert scale question focuses on the health of villages. Customers express their level of agreeance towards a statement on a scale of “strongly agree”/5 to “strongly disagree”/1. The statements are designed to give insight on overall health trends in villages. For example, if a large percentage of customers select “agree” or “strongly agree” for the statement “The bio-toilets have improved the health of my village’s children,” Banka Bio has data demonstrating that bio-toilet installation leads to better community health.

Prepared by:



## Section 4: Social Benefit

### Question 15

Please describe how the bio-toilet has affected women (Circle a number for each given statement).

	Strongly Agree	Agree	Neutral / No change	Disagree	Strongly Disagree
Women in my family use this bio-toilet (skip if no women in the family)	5	4	3	2	1
Women in my family feel safe when using this bio-toilet (skip if no women in the family).	5	4	3	2	1
Women in my family feel less scared at night when using this bio-toilet (skip if no women in the family).	5	4	3	2	1
Women in my family can go alone to use this bio-toilet (skip if no women in the family).	5	4	3	2	1
Women in my family have more dignity because of this bio-toilet (skip if no women in the family).	5	4	3	2	1

Rationale: This Likert scale question focuses on the bio-toilet experience and impact on women within the household and families. Customers express their levels of agreeance towards a statement on a scale of “strongly agree”/5 to “strongly disagree”/1. The statements are designed to give insight on women’s feelings towards the bio-toilets and if feelings of dignity, confidence, and safety have improved. For example, if a large percentage of customers select “agree” or “strongly agree” for the statement “Women in my family feel less scared at night when using this bio-toilet,” Banka Bio has data demonstrating that the bio-toilet leads to increased feelings of personal safety for women.

Prepared by:

### Question 16

Please describe how the bio-toilet has affected women in your village (Circle a number for each given statement).

	Strongly Agree	Agree	Neutral / No change	Disagree	Strongly Disagree
Women in my village use these bio-toilets.	5	4	3	2	1
Women in my village feel safe using these bio-toilets.	5	4	3	2	1
Women in my village feel less scared at night when using these bio-toilets.	5	4	3	2	1
Women in my village can go alone to use this bio-toilet.	5	4	3	2	1
Women in my village have more dignity because of this bio-toilet.	5	4	3	2	1
I would recommend this bio-toilet to the women I know.	5	4	3	2	1

Rationale: This Likert scale question focuses on the bio-toilet experience and impact on women within villages. Customers express their levels of agreeance towards a statement on a scale of “strongly agree”/5 too “strongly disagree”/1. The statements are designed to give insight on women’s feelings towards the bio-toilets and if feelings of dignity, confidence, and safety have improved. For example, if a large percentage of customers select “agree” or “strongly agree” for the statement “Women in my village feel less scared at night when using this bio-toilet,” Banka Bio has data demonstrating that the bio-toilet leads to increased feelings of safety among women in that particular village or community.

### Question 17

Do women who are actively menstruating use the bio-toilet?

This yes/no question focuses on social standards for women actively menstruating. The question is designed to give insight on whether women’s dignity and equality have improved. If a large percentage of customers select “no” Banka Bio could use this data to incorporate education and measures to protect female customers.

Prepared by:

## Section 6: Personal Benefit

### Question 18

Please describe how the bio-toilet has affected you (Circle a number for each given statement).

	Strongly Agree	Agree	Neutral / No change	Disagree	Strongly Disagree
Since having my bio-toilet, I am less stressed.	5	4	3	2	1
Since having my bio-toilet, I am less worried about my safety.	5	4	3	2	1
Since having my bio-toilet, I feel more respected.	5	4	3	2	1
Since having my bio-toilet, I feel more confident.	5	4	3	2	1
Since having my bio-toilet, my family is happier.	5	4	3	2	1
Since having my bio-toilet, my relationship with my spouse has improved (skip if no spouse).	5	4	3	2	1
Since having my bio-toilet, my overall quality of life is better.	5	4	3	2	1

Rationale: This Likert scale question focuses on the personal impact bio-toilet installation has had on customers as well how the overall quality of life of customers has changed since installation. Customers express their levels of agreement towards a statement on a scale of “strongly agree”/5 to “strongly disagree”/1. The statements are designed to give insight on customer’s feelings towards the bio-toilets and how the bio-toilets have affected the daily lives of customers. For example, if a large percentage of customers select “agree” or “strongly agree” for the statement “Since having my bio-toilet, my overall quality of life is better,” Banka Bio has data demonstrating that the bio-toilet leads to increased quality of life and as well as increased value of the bio-toilet.

Prepared by:

### Question 19

When at home, how many minutes (on average) would you travel to relieve yourself prior to bio-toilet installation?

Rationale: This is a multiple choice, personal benefit question. The purpose of this question is to determine if customers are saving time in their daily life since they have a toilet installed at home and to quantify the amount of time saved. For example, Banka Bio may use this data to find the average amount of time saved by customers due to bio-toilet installation.

### Question 20

Since toilet installation, do you have more time for other activities?

Rationale: This is a multiple choice, personal benefit question. The purpose of this question is to determine if customers have more time in their day due to having a bio-toilet installed at their house. If customers were previously traveling long distances in order to find another toilet or defecate in the open, having a bio-toilet readily available at home would save time throughout the day. Specifically, if customers select “yes” Banka Bio can conclude that their bio-toilets play a role in helping customers be more efficient and save valuable time that can be used towards other activities.

### Question 21

If YES, what has this extra time gone towards?

- a) Family
- b) School
- c) Household Chores
- d) Work
- e) Leisure Time
- f) Other (please explain): \_\_\_\_\_

Rationale: This is a multiple choice, personal benefit question. The purpose of this question is to determine, for those customers who claim to have extra time since bio-toilet installation, what that time has gone towards. For example, customers select “Family” Banka Bio can conclude that having a bio-toilet in the home allows customers to spend more time with their family and less time finding a place to use the toilet.

### Question 22

Any additional feedback about your bio-toilet?

Rationale: This is a general, free answer question asking customers for additional opinions or statements about their bio-toilet. This question could enable customers to cover any topic they wish in order to provide Banka Bio with personalized feedback that may not be covered in the remainder of the survey.

Prepared by:



## APPENDIX B - SUMMARY OF FINDINGS

### I. Bio-toilet Experience

All responses analyzed together:

- 98% of respondents agree that they use their bio-toilet while they are at home (n=51).
- 92% of respondents are satisfied with their bio-toilet (n=49).
- 100% of respondents agree that their bio-toilets are easy to use (n=49).
- 98% of respondents agree that their bio-toilet feels private (n=49).
- 96% of respondents agree that their bio-toilet is important to them (n=50).

Common complaints listed:

#### Cleaning

- “In open defecation, there was no problem of cleaning. If I don't clean the bio-toilet it starts to stink.”
- “Cleaning issue. How to clean the toilet?”
- “Cleaning material should be provided like some cleaning solutions as we were not allowed to use Harpic or any other chemical to clean.”
- “Give us cleaning material.”
- “Cleaning is an issue.”

#### Maintenance

- “Maintenance can be updated after 2-3 months.”
- “People should visit for maintenance purposes as we have paid for the bio-toilets.”
- “Request to concerned officials to visit once in 6 months for smooth functioning and solving user's problems. A phone call regarding the same will also be appreciated.”

#### Smell

- “Some solution to get rid of smell.”
- “Stinky at times.”
- “Slightly smells occasionally and cleaning becomes a problem.”
- “Smelling, as we cannot use chemicals to clean.”
- “Smelling issue.”

#### Space

- “Setup can be improved.”
- “Space is less.”
- “Space is small.”
- “Door- when closed, kind of a gap remains. It feels uncomfortable because of that as from the gap one can peep inside.”
- “Door does not close properly, gap remains, becomes uncomfortable.”
- “Difficulty to sit.”
- “Should be more spacious, painting it, better tank facility.”
- “I have sitting issues since I am old. More space should be provided.”

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## Water

- “Water flushing takes a lot of time.”
- “Flushing issue. Water does not go fast. We have to wait for water to flush out completely.”
- “Water goes slowly inside. Does not clean properly.”
- “Water does not go fast while cleaning/flushing. Therefore we have to wait, time gets wasted.”
- “Flushing water is time consuming.”

## II. Health

All responses taken together:

- 72% of respondents agree that bio-toilets have decreased open defecation in their village (n=50)

Split into category of owned previous bio-toilet vs did not own any previous bio-toilet:

- 77% of respondents who did not own a toilet previously agree that their bio-toilet decreased their own open defecation practices (n=13). Only 18% of respondents who previously owned a toilet agree that their bio-toilet decreased their open defecation practices (n=33).
- 67% of respondents who did not own a toilet previously agree that their bio-toilet has improved the health of their family (n=15). Only 26% of respondents who previously owned a toilet agree that their bio-toilet has improved the health of their family (n=35).
- 73% of respondents who did not own a toilet previously agree that their bio-toilet has improved their health (n=15). Only 26% of respondents who previously owned a toilet agree that their bio-toilet has improved their health (n=35).

## III. Personal Benefit

All responses taken together:

- 89% of respondents report feeling less stressed (n = 46)
- 95% of respondents report feeling less worried about their safety (n = 46)
- 95 % of respondents report having an improved overall quality of life (n = 46)
- 52% report feeling more respected and confident (n = 46)
- 63 % report feeling happier (n = 46)
- 11 of 13 respondents report having more time for other activities since bio-toilet installation.

When asked what this time has gone towards:

- 1 responded with family
- 4 responded with household chores
- 4 responded with relaxing
- 2 responded with work

Split into men/women:

- 17% of women report that their relationship with their spouse has improved but 57% of males report that their relationship with their spouse has improved

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Split into previous owners and not:

- Of those who previously owned a toilet 36% of respondents (n = 33) report feeling more confident while 92% of respondents (n = 13) who did not own a toilet previously report feeling more confident
- 100% of respondents who did not previously have a toilet report feeling happier since bio-toilet installation while only 48% of respondents (n = 33\_ who previously owned a toilet report feeling happier.

#### **IV. Social Benefit**

All responses taken together:

- 100% of respondents (n = 46) report that women in their family feel safe and less scared at night since bio-toilet installation
- 59% of respondents (n = 46) report that women in their family have more dignity because of their bio-toilet
- 97% of respondents (n = 44) would recommend this bio-toilet to others

Did vs. did not have a toilet previously:

- 84% of respondents (n = 13) who did not previously own a toilet report women in their family having more dignity since having the bio-toilet while only 48% (n = 33) of those who previously had a toilet report the same
- 74% of the respondents (n = 12) who did not previously own a toilet report that women in their village have more dignity since having the bio-toilet while only 46% (n = 30) of those who owned a toilet previously reported the same.

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## APPENDIX C - LITERATURE REVIEW

Surya and Sharma conducted a study to determine the negative health outcomes of open defecation on the under-five population in rural India. The study looked at five different factors when comparing communities that practice open defecation and communities that are open defecation free. These five determinants were: the number of diarrheal episodes in the preceding 2 weeks, in the preceding month, the wasting of the children, the underweight population, and the stunting of the children. The results of this study prove that the under-five population in the communities practicing open defecation had a higher number of diarrheal episodes in the previous 2 weeks and in the previous month than open defecation free communities (A. V. & Sharma, 2019). Prüss-Üstün et. al. also argue that 88% of diarrheal disease worldwide are due to inadequate sanitation and hygiene. These diarrheal diseases then lead to 1.5 million deaths per year (Prüss-Üstün & World Health Organization, 2008). Using these studies, we decided to survey customers regarding their personal experiences with upset stomachs and diarrhea before versus after bio-toilet installation. By doing so, the public health impact of bio-toilets can be analyzed.

Women are disproportionately affected by the health and social impacts of open defecation. A systematic review completed by Saleem, et. al. looked into how open defecation affects women and girls in lower-middle income countries. The authors found four common themes of impact on women and girls: health, sexual exploitation, threats to privacy and dignity, and psychological stressors. Other researchers explain that in leaving the home to defecate in the open, women are at risk of sexual assault and lack of privacy (Jadhav et. al, 2016) (Winter & Brachi, 2016) (Sahoo et. al., 2015). A focus group discussion of women in rural India found that 44% of participants experienced struggles in finding locations for open defecation and feelings of indignity (Hirve, et. al, 2015). Interviews in India by Sahoo et. al. demonstrated that without a toilet at home, 51 out of 56 women and girls experienced fear of being watched or intruded on by men. One of the goals Banka Bio set out to accomplish with the installation of toilets is increased dignity and health of women in particular. When conducting research on the actual observed impact of the installed toilets, we looked out for indicators of these specific markers expressed in the article.

Jain et. al. conducted an exploratory study in Bihar, India to assess the attitudes on open defecation following the government's push for installing toilets under the Swachh Bharat Abhiyan program. Mac conducted a study consisting of semi-structured group and individual interviews regarding the usage of household toilets in the Sirohi district of Rajasthan, India. Both found that the government-funded toilets do not fit the needs of users and hence often go unused. The government funding for these toilets is low and therefore the toilets lack basic necessities for use such as being odor free, comfortable, and using little water (Mac, 2018). Using this knowledge, we decided to survey customers about their experiences using Banka Bio's toilets. Survey questions were aimed at assessing the smell, privacy, and perceived importance of the bio-toilet.

We designed their survey questions to measure customer experience, health impact, social impact, and personal impact of receiving a bio-toilet from Banka Bio. The social impact of bio-toilets focuses on the benefit women in the family and community feel since having a bio-toilet whereas the personal impact measures the benefit of the surveyed individual. Using the sources presented above, the survey was created to focus on the aspects of one's life that are most likely to change after receiving a bio-toilet and eliminating the daily practice of open defecation.

Prepared by:

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