

Ecological Management of Human Excreta in an
Urban Slum: A Case Study of Mukuru in Kenya

Eunice Likoko

Examensarbete i Hållbar Utveckling 148

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EUNICE LIKOKO

Likoko, E., 2013: Ecological Management of Human Excreta in an Urban Slum: A case study of Mukuru in Kenya. *Master thesis in Sustainable Development at Uppsala University, Department of Earth Sciences, Uppsala University, Villavägen 16, SE- 752 36 Uppsala, Sweden*, No. 148, 41 pp, 30 ECTS/hp

Abstract: Informal settlements around the world are plagued by a general lack of essential infrastructure, scarce and strained resources. This has resulted in glaring sanitation and subsequent health problems. Kenya is a developing country with several informal settlements which lack systems for managing human excreta. Effective management of human excreta remains elusive in the highly populated informal settlements. Sanergy is a social enterprise that seeks to provide a sustainable human excreta management solution in Kenyan slums.

The purpose of this thesis is to assess Sanergy's project viability in managing human excreta in slums. This analysis is based on qualitative methodology consisting of open and semi-structured interviews, moderate participant observation, focus group discussions as well as some participatory tools such as brainstorming and neighborhood mapping. Additionally this study incorporates GIS mapping information, national and global statistics and a literature review to understand the different dynamics of managing human excreta in a slum context. The result of this paper's assessment shows the viability of the Sanergy project as a sustainable sanitation solution for Kenyan slums, and beyond.

Keywords: Sustainable Development, social enterprise, ecological sanitation, informal settlement, Fresh Life Toilets

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Summary: By nature, human beings all over the world visit the toilet on a daily basis. However, a significant part of the global population lacks toilet facilities. This global problem is worse in the informal settlements where there is a general lack of toilets. The limited functional “toilets” in informal settlements are unsafe, run down, overflowing with human excreta and unhygienic. The question therefore is where do they go to relieve themselves? Many people practice open defecation in bushes and other available spaces. This problem has presented a myriad of health related challenges in many parts of the world.

In Kenya, the slum dwellers are worst hit by this sanitation challenge due to a high population density and a lack of supporting infrastructure. Makeshift pit latrines, illegal toilet connections to the main sewer systems and lack of running water to support the flushable toilets present a sanitation nightmare in all Kenyan slums. In Mukuru slum in Nairobi, the picture is equally grim. Over the years, there has been an attempt to address the sanitation challenge but the efforts have been few, scattered and soon overwhelmed by the sheer magnitude of the problem. Sanergy entered Mukuru’s sanitation scene in 2010 after realizing there was an urgent need to realistically address this problem with a long term perspective in mind. Using a business model, the social enterprise outfit then began the process of setting up compost toilets in Mukuru slums to address the existing need. Through these toilets, branded ‘Fresh Life Toilets’, Sanergy seeks to provide decent toilet facilities to Mukuru residents and use the faeces and urine from the toilets to provide manure and energy for the market. Having been in operation for two years in the slums, one of the questions this paper looks at is, “Is there room for sustainability in this initiative?”

This study looks at ecological sanitation as a model for sustainable sanitation. The ecological sanitation concept uses faeces and urine as a resource for the production of fertilizer, biogas and energy. The study evaluates Sanergy’s work in Mukuru in order to look at the level at which its work is grounded on the principles of sustainable development. The analysis also tries to answer the question: How can human excreta be managed effectively and sustainably to enhance proper sanitation in an urban informal settlement? A qualitative data collection method was used with support from primary and secondary data. The evaluation of Sanergy’s work helps determine whether this concept of dealing with human waste is successful and shows how it can be used successfully in other slums in Kenya and other parts of the world that face sanitation challenges. The study concluded that the Sanergy waste management model can be used as a template for achieving the millennium development goal of ensuring all have access to good sanitation.

Keywords: Sustainable Development, social enterprise, ecological sanitation, informal settlement, Fresh Life Toilets

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1. Introduction

1.1 Background

2.6 billion people lack adequate sanitation in the world today. Sanitation here refers to the basics of preserving health. It focuses on the elimination of health risks related to the handling of solid and liquid waste and a community's water supply (Kirch 2008). Gaps in sanitation have persisted for many years and have been highlighted in different fora over the years. The diagram below shows a regional distribution of sanitation challenges in the world in the year 2000.

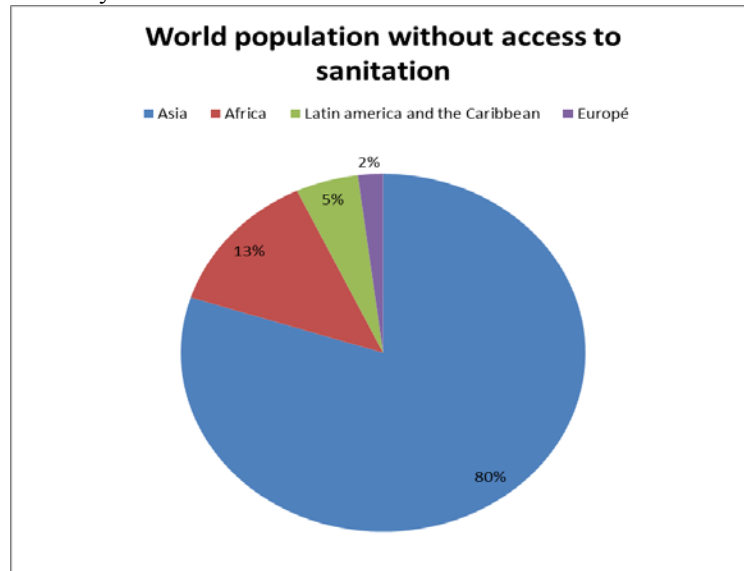


Figure 1: World population without access to sanitation, Diagram adapted from WHO (2000) statistics.

Industrialization and urbanization have led to migration and exponential growth in urban areas, principally in developed countries but also in less developed ones, where industrialization has been less, while migration from the rural areas has been higher. This has caused the mushrooming of informal settlements or slums contributing to the current global sanitation state (De Soto 2000). Informal settlements are unauthorized settlements where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally. They are unplanned settlements and not compliant to planning and building regulations (UN 1997). Global statistics show that approximately one in every three city dwellers lives in a slum (UN Habitat 2007:13). These slums are concentrated in developing countries. Urbanization has intensified sanitation challenges since a greater amount of people live in close proximity in urban areas. (Giddens 2006: 906). 37% of the developing world's population lack access to basic sanitation (JMP 2012).

Global sanitation challenges are closely linked to other variables in the immediate surrounding such as the physical environment and ecology. The ecological composition of many environments has evolved significantly with industrialization and urbanization. Ecology examines how living organisms adapt to their environment (Giddens 2006: 895). Urbanization has had adverse effects on ecology. The high population density in urban areas leads to a dramatic increase in waste generation. Urban environments are overwhelmed by the amount of waste received because human waste is disposed of in the environment. This affects the quality of water in an area and the sanitation of an area causing disease and death. Informal neighborhoods are worst hit as they lack the basic sanitation structures like clean water and working toilets (Spellman 2010). Urban and peri-urban areas are most affected by poor sanitation which causes diseases and pollution. A lot of the global sanitation challenges are caused by lack of effective toilet facilities (Sida 1998).

In Kenya, "only 24.3 % of the population have access to adequate sanitation facilities" (KNBS and ORC Macro 2010). This means that the bulk of the population grapple daily with poor sanitation and its consequences which include a high prevalence of infectious diseases like cholera , general poor health and environmental pollution. 55 % of the urban Kenyan population lives in the slums. Population density in the slum is high with the slum dwellers being forced to survive on 1.5 percent of the total urban land (Homeless 2013). This high population density has adverse effects on the residents' sanitation and the environment.

Nairobi is Kenya's capital city and it is home to at least 5 major informal settlements. According to Kenya's official election website in the 2013 general elections, Nairobi has a population of 3.1 Million (KED 2013). Rapid population growth in Nairobi has led to poor sanitation and catastrophic levels of environmental degradation over the years. (UN-HABITAT 2005). This is seen in the pathetic waste management system and pollution of the water bodies in Nairobi. Nairobi has a sanitation policy whose implementation is ineffective and disjointed. According to the World Health Organization, the child mortality in the slums is 2.5 times higher than in the rest of Nairobi due to poor factors that include poor sanitation (WHO 2008).



Figure 2: Map showing the location of Nairobi in Kenya (Kenya 2011)

“Nairobi has the highest population growth rates per annum compared to the other growth rates in Africa. 75% of the urban population growth is absorbed by informal settlements. The number of urban population living in slums will double in the next 15 years. Informal settlements cover only 5% of the total residential land area of the city, but they are inhabited by at least half of the city's population.” (UN-HABITAT 2005)

This thesis is based on a case study of a human excreta management organization based in Mukuru slum in Nairobi. Sanergy is a social enterprise that works to eliminate the sanitation challenge in this informal settlement by providing human excreta management services. Mukuru is one of the many existing slums in Nairobi. It is located in the eastern side of the city. It is one of the largest slums in Kenya's capital city with a population that exceeds 600,000. Mukuru has three major subdivisions namely: Kwa Reuben, Kwa Njenga and Kayaba (Sanergy 2011). Mukuru is located near the industrial area in Nairobi. The area of the slum that is adjacent to the industries is referred to as Viwandani. For purposes of this case study, we will focus on Kwa Njenga, Kwa Reuben and the Viwandani area. Mukuru like other informal settlements is plagued with poor sanitation. Its environment is characterized by dumpsites, lack of running water, a poor and almost non-existent system for managing human excreta, lack of infrastructure and a river full of raw sewage and other liquid and solid wastes. These challenges are by-products of today's 'development' and are a real barrier to societal progress (Sida 2004). GIS or Geographic Information Systems capture, analyze and store information about different locations by use of computer software and land surveying techniques. GIS maps help illustrate the lines of communication used in Mukuru, the layout of the residential places and sanitation related points like water bodies, dump sites and mapped public toilets to increase an overall understanding of the area. The following are basic GIS maps of Mukuru produced by Map Kibera Trust in a recent initiative to develop accurate and informative maps for the informal settlements in Kenya:

MUKURU KWA NJENGA-WATER AND SANITATION

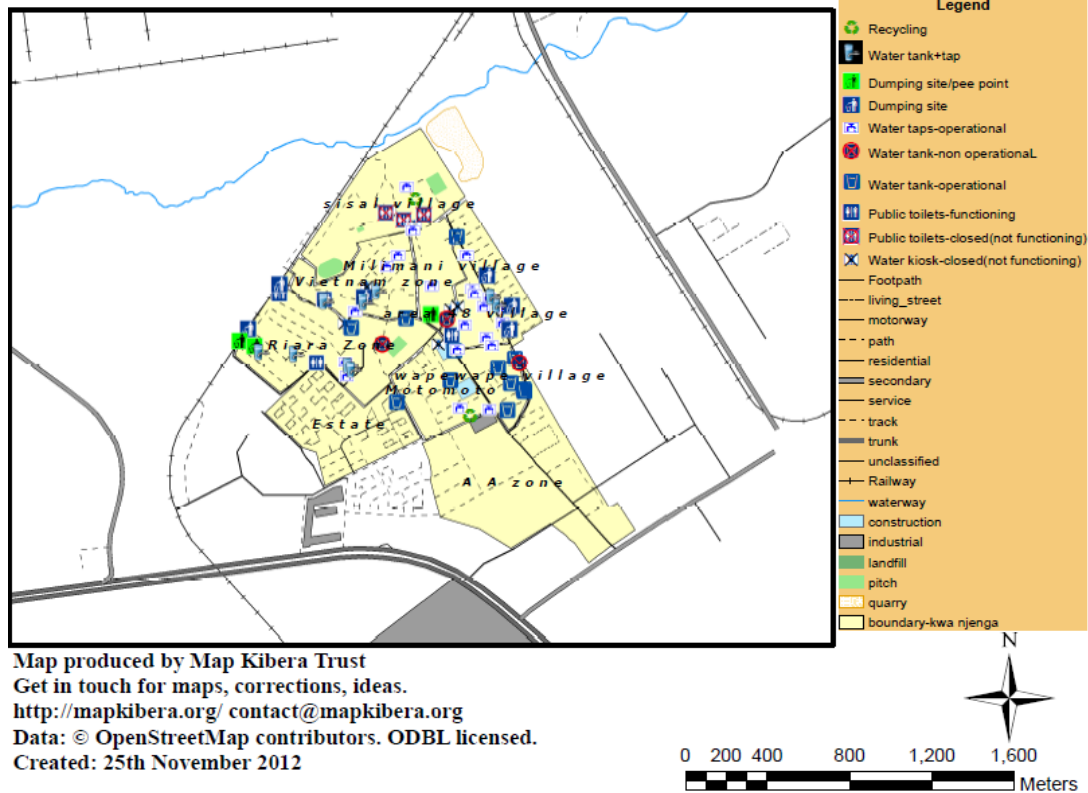


Figure 3: Water and sanitation map Mukuru Kwa Njenga

MUKURU KWA REUBEN-WATER AND SANITATION

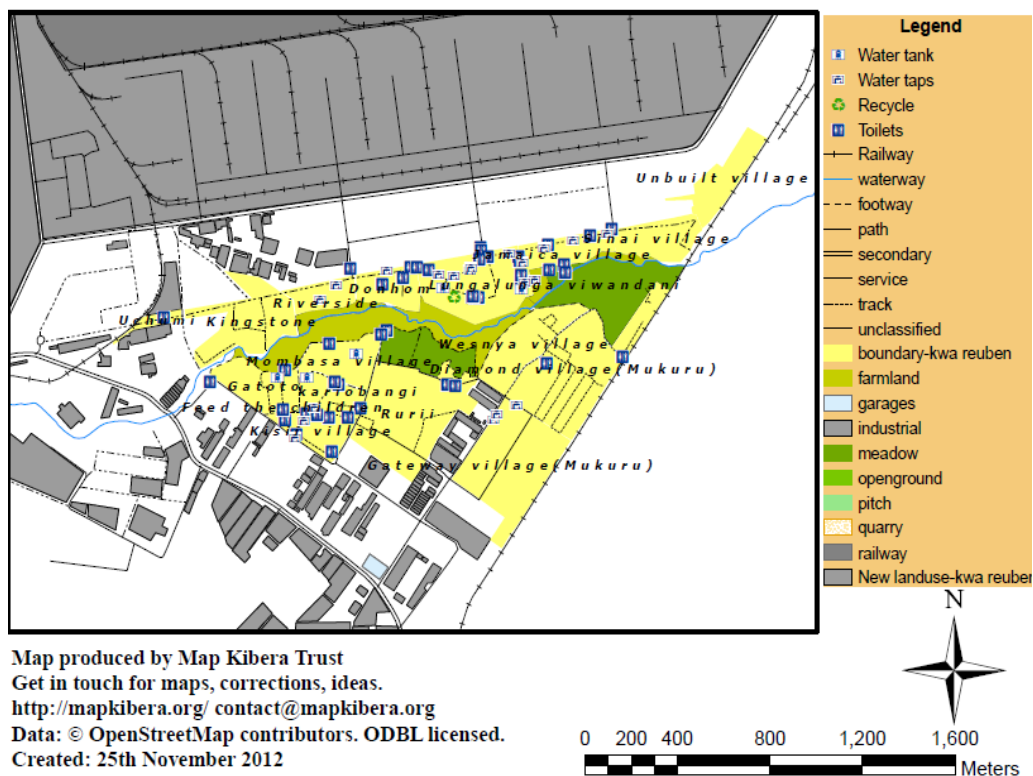


Figure 4: Water and sanitation map Mukuru Kwa Reuben

With this socio-economic and geographical parameters in mind, there is a dire need to address these sanitation challenges and to adapt functional sanitation alternatives around the world that manage human excreta in informal areas in order to enhance sanitation.

1.2 Purpose and aims

The purpose of this thesis is to assess Sanergy's initiative as an ecological solution to the sanitation challenge in Mukuru slum. It investigates the viability of the compost toilet initiative as an ecological sanitation solution that is implementable not only in urban informal settlements but also in other areas in Kenya and other water scarce countries. This research aims to answer the following question: How can human excreta be managed effectively and sustainably to enhance proper sanitation in an urban informal settlement? The study uses the principles of sustainable development to assess the viability of the project and seeks to point out the specific elements that make it successful, elements that hinder its success and areas that need improvement. Hence the focus of sustainable development should be multi-faceted, multi-sectorial and with multiple interest. For the purposes of this study, we will focus on managing human excreta in a way that is sustainable, that is, in a way that is good for the society, for the environment, for the economy and for future users of the resources in the environment. This is a context specific qualitative research (Education 2006) that looks at ecological sanitation in an urban informal settlement.

2. Methodology

The research methodology for this study mainly consisted of primary sources like maps, secondary sources like literature review and empirical data. The tools used included open and semi-structured interviews, participant observation, focus group discussions, as well as some participatory tools such as brainstorming and neighborhood mapping. Additionally this study incorporates national and global statistics, a literature review to understand the different dynamics of managing human excreta in a slum context and the use of GIS mapping produced locally by map Kibera Trust.

This study is based on a case study of one organization operating in one slum in Kenya hence it is in no way representative. However, it allows us to explore the workings of ecological sanitation in a specific context in order to gain a deeper understanding and make an analysis that is relevant to our research purpose. Sanergy was identified as a case study subject at the World Water Week (2012) in Stockholm. Sanergy's model of operation was identified as an example of an innovative model of dealing with human waste in a resource scarce and highly populated urban informal settlement. After initial consultations with its leadership team, Sanergy approved the idea of conducting a case study of their organization.

To carry out the empirical study, prior planning for the data collection was done. The research was mapped to take place in three main phases;

- (i) The Preparation phase
- (ii) The Data collection phase
- (iii) The compilation phase.

The preparation phase involved reading literature and reports to get background knowledge on the organization and understand the working of ecological sanitation. The findings from these reports are documented in the 'Introduction' and the 'Literature review' sections of this study. This background knowledge informed the development of my fieldwork research plan. Through prior correspondence with Sanergy staff members and the background information gathered, the data collection phase was scheduled for the month of February 2013, for a month. Similarly, the preparation included developing questionnaires and interview questions that target different aspects of the human excreta management system set up by Sanergy.

Based on the background information gathered before the commencement of data collection before going to the field, I had designed 6 different open ended questionnaires targeting the following key informants:

- Sanergy Staff,
- The operators of the toilets,
- The Community members (Users and Non-users of the toilets),
- Stakeholders-the farmers who buy the fertilizer, government representatives- from the local government and the Ministry of Public health and Sanitation.

The key informants can be broadly classified into two categories; the residents of Mukuru and the people involved in human excreta management. The residents of Mukuru were selected because they are residents in areas where Sanergy's Fresh life toilets have been installed. They include the users, non-users and operators of the Fresh Life Toilets who understand how the Fresh Life Toilets work. The people involved in the human excreta management are the key informants who qualify to be key informants because they have a deeper understanding and/or a specific role in the waste management cycle at Sanergy organization. They include the Sanergy Organization workers and government officials.

The questionnaires were designed in English and were translated to and administered in Swahili and Sheng (an informal language which is popular with the urban youth and in non-professional circles in Kenya).

In order to record the findings during the research, it was necessary to acquire the following equipment; a voice recorder, a camera for taking pictures and videos, writing material, drawing material and printed out questionnaires. These would help record the observed events and the responses from the interviews.

Before beginning actual process of data collection in Mukuru slums, an initial meeting with one of Sanergy's founders, an initial tour of the Sanergy's areas of operation in Mukuru slum and an orientation tour of Sanergy's premises and waste management processes were scheduled. These three orientation opportunities led to a revision of the questionnaires as they pointed out other respondents who would enrich the research process.

The Data Collection Phase of this research was carried out in Mukuru slums in Nairobi and at the Sanergy premises in Nairobi's Mukuru slum. It took one month and this allowed me to spread out the interviews and conduct them singlehandedly. Sanergy works in three main areas on Mukuru Slum and hence this research was confined to these three areas namely: Kwa Njenga, Kwa Reuben and Viwandani. The respondents were sampled from these three areas through purposive sampling (Trochim 2001). Purposive sampling allowed the research to target equal number of respondents from these three areas in a deliberate attempt to collect data that captures the views of residents from the different areas within the slum.

This research was designed as a qualitative research in order to capture the perceptions, opinions and interpretations of the interviewees that contribute to understanding the issues related to our research question and understand non-quantifiable aspects of the research question

All the interviews were to be audio recorded in order to capture the different aspects of the responses. Four major data collection methods (Ngau 2004:97) were employed in namely: participant observation, use of questionnaire, interviews, focus group discussions and analysis of GIS maps.

2.1 The Participants

Different data collection methods were employed for different groups of informants. Data collection from the groups of informants that had more than 10 respondents was done using structured questionnaires with a combination of open and closed ended questions. The interviewer randomly selected toilets in the three sub-regions of Mukuru slums and waited outside the toilet for respondents on different days and times. The anonymous respondents to the questionnaires were randomly identified through purposive and convenience sampling (SAGE 2008:464) as they visited or passed by Sanergy's Fresh life toilets in different parts of Mukuru. The specific respondents were not previously identified; they were picked randomly as they left the toilet. Each questionnaire took between 5 to ten minutes to fill depending on how much information the respondent shared.

Some questionnaires took longer for example a fruit vendor in their roadside business premise, was interrupted by customers who stop by to purchase fruit as the interview was going on. In the end, there was a higher male representation among the respondents as seen in Table 1 below.

A focus group discussion (Amoakohene 2004:29) was used to collect data from the operators of Fresh Life Toilets in order to get an in-depth understanding of their perceptions. The focus group discussion was held at the Sanergy premises. The participants were selected through purposive sampling with the help of Sanergy's field workers. The participants were all operators of a fresh life toilet in Mukuru slum. In order to have a rich and representative discussion, the participants were picked to represent different genders, different success rates in their business and the three regions of Mukuru Slum. In order to capture the experiences from the different types of toilets, and have a rich discussion, the focus group discussion had representatives from: operators of independent commercial Fresh Life Toilets, operators of Fresh Life Toilets located within a plot (an enclosed cluster of houses owned by one person) and operators of Fresh Life toilets located in slum schools. Despite inviting a total of 12 participants to the focus group discussion, only ten were able to confirm attendance. The other two were busy. On the day we held the focus group discussion, only 5 were able to make it to the meeting. Two operators who run toilets in schools were unable to make it to the meeting because the slum schools are understaffed and they could not take time off on that day during school hours to attend the FGD. They availed themselves afterwards for in-depth interviews. The total number of respondents was 7.

The respondents who participated in the focus group discussion hailed from different parts of Mukuru Slums. They each received a transport allowance to facilitate their travel to and from the focus group discussion. All the other respondents did not receive any form of compensation for their participation in the research. The focus group discussion took one hour. We however had to wait for the latecomers. The group discussed the different questions and their feedback was recorded on flipcharts and using a voice recorder. The group could not participate in the previously planned problem tree participatory method that included them writing down their responses because some were unable to write. The method was modified and instead we had one person recording the responses on flipcharts for all to see as the discussion went on.

In-depth interviews also served to give information on the process and technicalities of the Sanergy waste management model. The interviewees were staff members at Sanergy and a government authority who understands the dynamics of Mukuru's sanitation issues. They were selected through purposive sampling based on the relevance of their role to the research question. A total of 12 interviews were conducted. This was different from the initial plan to interview 5 key informants in the organization. As we started the interviews it was necessary to interview other staff members who were not obvious respondents at the planning stage. The interviews with the staff members and the local authority took about 20 minutes each. However, some like the waste management team, took longer because they had to explain the step by step waste management processes and demonstrate the processes at the waste processing site. The data collection tools worked well and we used different tools for different groups of respondents in different parts of Mukuru.

The following table shows the different categories of people who participated in the research, the data collection methods and tools used to collect data among the different respondents, and gender information of the respondents interviewed using structured questionnaires. A total of 11 target groups were interviewed as shown in the Table 1 below:

Table 1: Data collection methods and tools

No.	Target person/group	No of people interviewed	Gender		Data Collection Method	Tool(s) used
			Male	Female		
1.	Sanergy Organization Leadership team	1	0	1	In-depth individual semi-structured interview	Questionnaire*. Voice recorder
2.	Users of Sanergy Fresh Life Toilets	30	18	12	Structured questionnaire	Questionnaire*
3.	Non-users of Sanergy Fresh Life Toilets	10	6	4	Structured questionnaire	Questionnaire*
4.	Operators/Owners of Sanergy's Fresh Life Toilets	7	3	4	Semi-structured Focus group discussion, participatory methods like brainstorming, participant observation	Questionnaire*, flipcharts, voice recorder
*	Sanergy's team for sourcing Construction Materials	1	1	0	Semi-structured questionnaire	Inventory list* for materials used to deliver a fully functional toilet.
6.	Sanergy Organization's Field workers	2	2	0	Semi-structured interviews	Questionnaire*, voice recorder
7.	Fresh Life Toilet Construction team	2	2	0	Semi-structured interview, participant observation.	Voice recorder, questionnaire*.
8.	Fresh Life Marketing team	2	2	0	Semi structured interview	PowerPoint presentation, voice recorder, questionnaire*
9.	Sanergy Waste management team	3	2	1	Semi structured interviews , participant observation	Voice recorder, camera, questionnaire*
10.	Sanergy Fertilizer specialist	1	1	0	Interview. Participant observation	Voice recorder, questionnaire*
11.	Local Government representative	1	1	0	Semi-structured interview	Questionnaire*
* All the questionnaires are available in the appendix section on pages 31-35.						

During data collection I also used the participant observation method to collect data while I spent time in Mukuru. Florence Kluckhohn (1940) defines the role of a participant observer “a conscious and systematic sharing in so far as circumstances permit, in the life activities, and on occasion, in the interests and things that affect a group of persons”(Kluckhohn 1940:331). I spent days walking the streets, observing and participating in the “sanitation life” of the Mukuru residents as I stationed myself to interact with residents to gather information about the Fresh Life Toilets. This form of observation allowed me to me understand the sanitation situation and the human excreta management systems in Mukuru better; and hence refine my questionnaire to capture relevant information in the study area. Geographic Informative system (GIS) mapping was also used to look at the overall layout, landmarks and features in Mukuru, in relation to each other. The GIS maps helped to show the different parts and activities in Mukuru.

2.2 Limitations of the research design

The research generally proceeded without hitches. However, the focus group discussion did not attain the ideal number of participants as several of them did not show up. Some respondents to the users and non-users questionnaires were initially suspicious of being interviewed and some wanted to get Sanergy branded t-shirts in exchange for their answers, but they all eventually responded at length. We were also unable to reach the owner of the only single family toilet installed by fresh life due to his busy schedule and hence we did not get data from a toilet used exclusively by one household.

Some of the random respondents who were to respond to the non-user questionnaires were visiting or passing through Mukuru slums. Since they were not residents of Mukuru they were eliminated from the list of respondents. This research was based on an ongoing project and the open ended questions generated feedback that was not relevant to the research but had to do with Sanergy's operations. This feedback was compiled and relayed to the Sanergy at the end of the data collection period.

The initial plan was to audio record all the interviews. However, upon evaluating the Mukuru slum security status, it was unsafe to use the voice recorder gadget in the slum streets as it attracted unnecessary attention and made the respondents suspicious. There was also too much noise from the surrounding industries and activities hence it was not realistic to do an audio recording.

Besides the interview from the local government representative, no other meaningful interview was possible with the relevant government officials due to bureaucracy and their unavailability in the offices during the research time which was preceding the sensitive political Kenyan general election period of 2013. It was not possible to interview the farmers who have used the fertilizer samples due to their unavailability during the fieldwork and the fact that the month this field work was conducted was the just before the next planting season hence there were no crops growing in the Sanergy fertilizer trial farms. After initial inquiries and understanding of the progress done with developing the fertilizer, we found it useful to interview the Sanergy fertilizer specialist instead, to obtain information on the details of fertilizer development and use.

In addition some geographical information that is important for this study was not available in the GIS database. The use of participant observation is also susceptible to researcher bias in the presentation and interpretation of the data.

3. The case study: Sanergy

In most countries around the world, the local authority has the mandate of providing sanitation enhancing infrastructure like clean water and a working sewerage network. The informal nature of slums makes their existence unlawful. This has made it possible for the central government to justify the failure of the local authorities to provide sanitation facilities in these illegally constructed spaces (De Soto 2000, pg.98). According to SIDA (1998), the most common toilets around the world are the pit latrine and the flush toilet. Globally, only a small percentage of the population has access to WCs. (SIDA (1997). Mukuru slum is not an exception. Pit latrines are a common toilet solution. Slum neighborhoods lack the resources and infrastructure to install and maintain flush toilets and the routine maintenance necessary for pit latrines; hence they are subject to pathetic hygiene conditions.

Due to a lack of adequate and accessible latrines slum dwellers in Kenya have resorted to defecating in plastic bags to dispose of human excreta; these are thrown in the open drainages and are referred to as "flying toilets". Others use the few remaining bushes or pay a small fee to use pit toilets. The waste in these latrines often ends up in the water surface and underground water reserves due to high water levels and poor construction and maintenance of the toilets (McKenzie&Utgard 1975). The public health effects of these practices range from water pollution to increased mortality due to communicable diseases. Preventable hygiene related diseases are a leading cause of death among children in Kenya (Next Billion 2012). The impact of proper sanitation cannot be overstressed.



1 .An average toilet in the Mukuru slums: photo by Marielle Schweickart (Kiva 2012)

2. A toilet emptying untreated waste into a river in the slum with evidence of open defecation in the foreground: Picture by Sanergy (2012)

In an attempt to improve human excreta management in the Kenyan slums initiatives like the one time use biodegradable polythene bag called the Peepoo bag (Peepoople 2007), pit latrines, WCs that are flushable with a bucket of water and neighborhood septic tanks have been introduced with little success due to poor infrastructure, water scarcity and high cost of maintenance of the sanitation option. Lobby groups have also advocated for long term public investment in slum sanitation infrastructure, but these attempts have not been successful.

These challenges led to the emergence of Sanergy organization as an attempt to bridge this sanitation gap. Sanergy is designed as a social enterprise. According to the European Commission Enterprise and Industry dictionary a social enterprise's activities focus on achieving a wider social or community objective. A social enterprise combines the entrepreneurial focus of the private sector with an objective of achieving a societal purpose (EC 2013). Sanergy is a sanitation franchise designed to provide an ecological system for managing human excreta in urban slums. The organization is based in the sprawling Mukuru slum, in the Eastern part of Nairobi. Sanergy works on three parts of Mukuru namely: Kwa Njenga, Kwa Reuben and Viwandani area. These areas are further subdivided into a total 19 smaller villages that make is easier to differentiate the different parts in the slum. Sanergy began with an idea by a group who then enrolled into an interdisciplinary development ventures class with an aim to use the class forum to shape the idea of the project and refine it as much as possible before starting to develop the idea further and implementing it in Kenya. Sanergy's vision statement outlines their implementation strategy in the following four parts:

- “(i) building a network of low-cost sanitation centers in slums,
 - (ii) distributing them through franchising to local entrepreneurs,
 - (iii) collecting the waste produced, and
 - (iv) processing it into electricity and fertilizer.
- At each step, this model creates jobs and opportunity while simultaneously addressing serious social needs” (Sanergy 2012).

Sanergy has built, distributed and been operating compost toilets which are called “Fresh Life Toilets” in different parts of Mukuru. Fresh Life Toilet is the brand name for compost toilets designed by Sanergy. A compost toilet is a human excreta disposal system that utilizes no water and has a waste receiving tank in which aerobic bacteria break down the waste (Bellingham 2010). Conventional compost toilets have relatively large chambers underneath the toilet structure that allow the faeces and urine to be processed into fertilizer on site. The Sanergy toilets on the other hand, have a centralized waste processing system where all the waste is collected from the individual toilet units and processed centrally into fertilizer. Sanergy is a non-profit organization registered as a company in Kenya. It is a non-profit organization because its primary aim is to meet the needs of the society around it hence the income it generates is used to maintain the franchise activities that make the provision of sanitation possible. The franchise idea was the most effective option to provide as many people as possible as it eliminated the problem of trying to get land in a highly populated area. The users of the toilet pay a small fee every time they need to visit the toilets. This fee is the income for the toilet owners. The profit motivation of the Fresh Life Toilet owner without worrying about the waste from the toilets was a promising option to get franchise buyers interested and keep them motivated to run the toilet. Sanergy's initiative is an award winning sanitation venture into uncharted waters in the Kenyan context and especially in a challenging urban informal settlement context.



Sanergy's Fresh Life Toilets: Pictures by Likoko (2013) and Sanergy, respectively.

4. Literature review

Development discussions and practices have metamorphosed over the years from a focus on “industrialization” to a focus on “economic growth” and more recently sustainable development (Hall & Gieben 1992). Industrialization and economic growth thrive on maximum exploitation of the existing resource base (Giddens 2006). An evident increase in the depletion of all types of resources used to support the production process and human lifestyles has led to a paradigm shift and the emergence of sustainable development. Strange defines development as, “the act or process of developing; growth; progress” (Strange 2008:24). Strange further says that, “Sustainable development is about integration: developing in a way that benefits the widest possible range of sectors, across borders and even between generations. Decisions should take into consideration potential impact on society, the environment and the economy, while keeping in mind that: our actions will have impacts elsewhere and our actions will have an impact on the future” (Strange 2008:24). Gordon Mitchell et al (1995) discuss four main guiding principles of sustainable development, namely: environment, futurity, public participation and equity. This means that for development to be deemed sustainable, it must have a concern for protecting the integrity of ecosystems, a concern for future generations, a concern that individuals can participate in decisions that concern them and a concern for those who are disadvantaged. Mitchel argues further that based on these criteria one can go further and determine if a project has weak or strong sustainability. Strong sustainability is possible where the progress in a region is equitable and preserves the environment whereas weak sustainability is probable where progress is limited to technological advances. The ecological sanitation concept is based on the principles of sustainability.

Ecological sanitation is any practice that seeks to manage human excreta by channeling the nutrients into the soil to restore soil nutrition while at the same time eliminating the lack of systems for human excreta management in places that lack sewer systems (SOIL 2006). It promotes sustainability. Sustainability is continuous and pursues a balanced society and environment while addressing the ecological, the social and the economic angles. (WWF 2008:16). As seen in the introduction, many global sanitation solutions are riddled with challenges and do not meet the sustainable development standards.

According to Langergraber & Muellegger, “a sanitation system that provides Ecological Sanitation (EcoSan) is a cycle—a sustainable, closed-loop system, which closes the gap between sanitation and agriculture. The EcoSan approach is resource minded and represents a holistic concept towards ecologically and economically sound sanitation. It is a systemic approach” (Langergraber & Muellegger 2004). EcoSan focuses on promoting sustainable development by reducing the resources used to handle human waste and channeling the nutrients in human excreta back to the soil. It views the nutrients in human excreta as a resource that gets processed and is eventually used for agriculture and other uses like generating energy. EcoSan strategies are area specific and differ from one environment to another. It operates by combining different waste management systems and bringing them together to manage waste effectively (Langergraber & Muellegger 2004).

According to the Proceedings from the SIDA Sanitation Workshop (Sida1997), there are three main types of human excreta management: “(i) drop and store, (ii) flush and discharge, and (iii) sanitize and reuse. The “sanitize and reuse” systems are referred to as ecological sanitation. This is because they encourage the ecological principles of zero pollution, recycling and water conservation” (Sida 1997:11). The report alludes to the fact that the technology being used in very few communities and staying unknown in most parts of the world. Its adaptation has been slow due to poor information dissemination, making appropriate designs for different contexts and implementation related hurdles (Sida 1997:11)

An example of an ecological sanitation solution is a compost toilet. Compost toilets are dry toilets that do not use water to take the waste somewhere else. Natural decomposition that uses natural atmospheric bacteria and time are used to produce fertilizer (SEI 2004). The below diagrams illustrate the basic idea of how a compost toilet works.

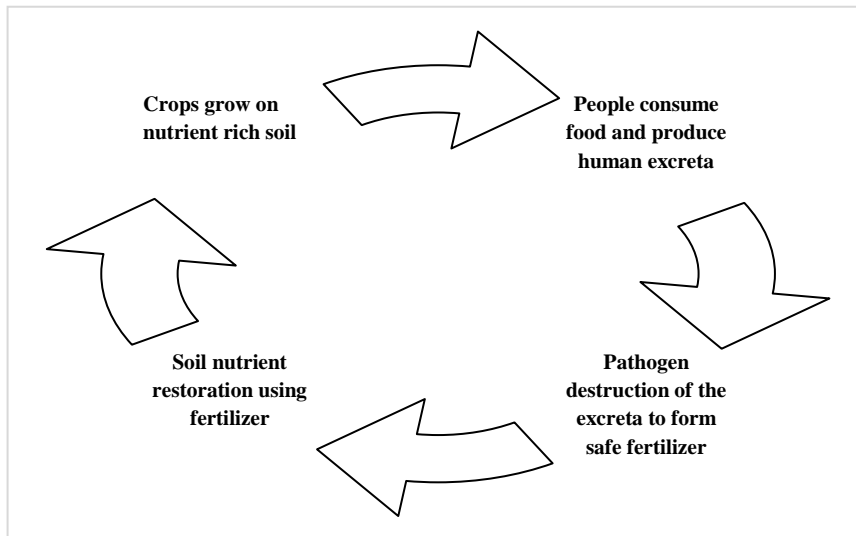


Figure 5: Ecological sanitation as a closed loop system

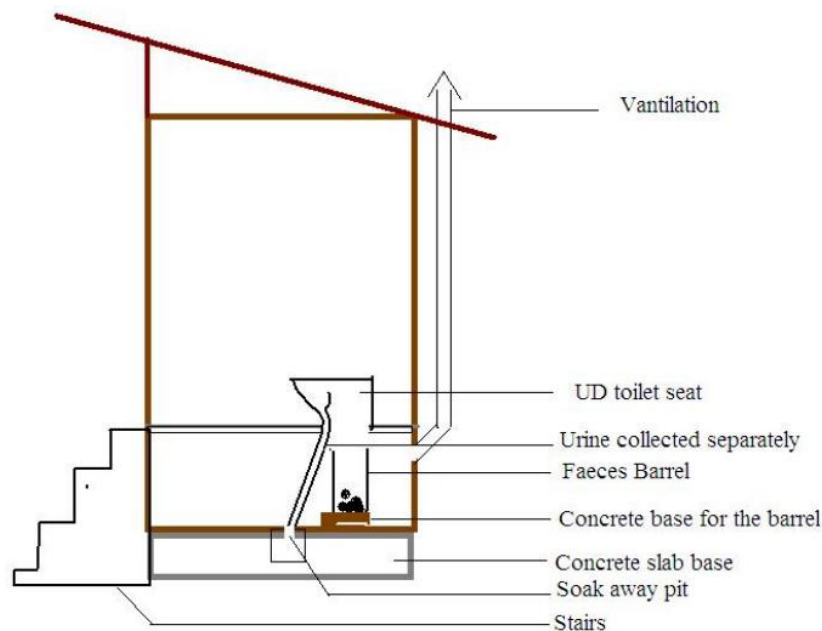


Figure 6: A cross-section of a urine diversion toilet. (Sidiqqi, Likoko et al 2012)

In 1998, another study by Sida examined the whole concept of ecological sanitation by relating it to a system because different sanitation options will have varied advantages and shortcomings under different physical and cultural conditions. The study by Sida asks the question, “How can Ecological Sanitation work on a large scale, such as an entire town or city?” (Sida 1998:73). The research examined a few large scale examples of ecological sanitation but had no example of existing city wide examples. The research was even more concerned about developing country cities and their infrastructural challenges that further complicate the sanitation challenge. In order to apply the findings of this research, they resorted to developing an imaginary urban city with what they refer to as “typical characteristics”. These typical characteristics assume a sanitation system that is planned for at the central government level and by a government that is truly concerned about the welfare of its citizens. This recommendation for ecological sanitation though noble, is far from the reality of the Kenyan slums and many other slums in developing countries. The slum dwellers in developing countries are not factored in most government development plans (De Soto 2000). Hence the proposed ecological sanitation framework will be difficult to implement in a context where there is no infrastructure, budget or personnel. Therefore the findings of this research are informative and provide a general implementation plan but it fails to address the needs of places where government systems are either non-existent or have collapsed altogether.

In 2004, based on implementation of ecological sanitation projects around the world, The Stockholm Environmental Institute (SEI) published the findings of yet another research. This study looks at different designs of ecological sanitation toilets and different places where it has been implemented. The study concludes by providing a vision that helps implement ecological sanitation in urban spaces.

In its 1997 publication, Sida published an assessment of the re-use toilet systems that separate urine and faeces in Sweden. The study looked at the hygiene standards, the entire waste management system, resources used, socioeconomic parameters and the effect on the environment. This is an attempt to have a holistic evaluation that considers the entire context in which the sanitation system operates to get a better understanding of how it works. The study points out that the study should be context specific and that evaluation should be based on the location where it will be implemented (Sida1997:21). This study is similar to my research idea in terms of its overall holistic approach to investigating the ecological sanitation systems. However, the contexts in which the researches were carried out differ greatly as Sweden is a highly developed context with a low population and a wide resource base whereas Mukuru is a slum context with a very high population density and highly overstretched resources.

Another study was conducted by the Burkina Faso Ministry of agriculture and the Japan International Cooperation Agency (JICA) investigated the feasibility of ecological sanitation in rural Burkina Faso. The research was on the project dubbed sustainable Agro-sanitation model and was aimed at finding ways of improving the poor sanitation levels in the country. The Ecological sanitation model was found to have adapted to the local conditions through innovation, teaching and information dissemination. The success of the project on rural Burkina Faso was because in the rural areas many homes previously lacked built toilets hence sanitation standards were very low and the different homesteads now used their fertilizer from the newly constructed compost toilets in their farms, hence making the toilets popular. However, the model was not as easily adapted in the urban areas of Burkina Faso because the urban population has no need for fertilizer and hence lacked the motivation to adapt the ecological sanitation model. (SOU/DAKOURE 2010)

In South Africa's eThekweni municipality, a research on ecological sanitation based on the urine diversion toilets was done in an urban municipality similar to the slum context being investigated in Kenya. The research was a quantitative study requested by the municipality. The research purpose was to "to describe the baseline situation in respect of sanitation, safe water and hygiene behaviour in intervention" (Lutchminarayan 2007, pg. i), in areas that were supplied with the urine diversion toilets and compare these to Control Areas. This study was conducted under the department of public health hence the study was investigating health implications of the urine diversion ecological toilets on health. The study concluded that the urine diversion toilets were successful in improving hygiene standards and were recommended as a necessary hygiene enhancement option for the research control areas. It does not look at the sustainability of the project, however it recognizes the need for what it terms as "sustainable education on matters of hygiene" in order to make people embrace the urine diversion toilet to enhance sanitation (Lutchminarayan 2007).

In 2012, Sanergy organization carried out a quantitative baseline study and consolidated information about Mukuru by interviewing 100 operators, 474 users and 279 non-users of the Fresh Life Toilets. This non published internal research was designed to quantitatively understand the factors that influence usage of the Fresh Life Toilets as well as developing a knowledge base for future measurement of the effectiveness of sanitation intervention and the impact on the lives of people using the toilets. This research provided quantitatively measurable parameters to be used for monitoring and evaluating the project's growth over time. It also shed light on the general hygiene standards in Mukuru but does not focus on our research purpose of determining if the project qualifies to be "sustainable". This research though conducted in a scientific manner, is not published but is available in the organization's internal documents

Though informative and useful in providing an understanding of ecological sanitation options, the above researches and available information on ecological sanitation fails to answer the question of managing human excreta effectively and sustainably to enhance proper sanitation in an urban informal settlement; hence my research.

5. Results

The results of the case study upon which this thesis is based, are presented here based on the methods used for data collection; participant observation, the semi-structured open ended questionnaires, the interviews and the focus group discussions.

5.1 Participant observation results

Participant observation involves an ongoing process of interpretation of observed phenomena and events so as to make sense of the event; hence it is difficult to present random observations without a discussion of the significance of the observation to the slum sanitation reality. Using participant observation techniques, I observed the state of sanitation in the slum to be poor especially in the areas near the railway which also act as dumpsites. Many of the dilapidated latrines stand next to the railway. Similarly, I saw that open defecation is rampant on the railway reserve land and the bushes near it. This railway reserve is also the location of many dilapidated pit latrines used by the local pubs and other entertainment spots.

I learnt that many of the slum houses (one small room made of tin or concrete structure partitioned using big pieces of cloth) under one landlord did not have toilet facilities and this is commonly known to the tenants as they move into the houses and it is one of the reasons why the slum houses are cheap. The landlord is not expected to provide toilet facilities in most parts of the slum.

During the process of filling out questionnaires next to the different toilets, I saw that all the toilets in an area have a similar price tag and that the users of the toilets come prepared to pay for this “service”. It is normal in the slum context for one to pay to access a toilet. There is no clear structure or maintaining toilet facilities and I noticed several abandoned pit latrines because they are full. One of the common income generating activities for the slum based community based groups is to set up a sanitation facility that sells water, showering and toilet usage facilities. Upon probing further, it was also clear that lack of good toilet facilities is not a new problem, those who were either born or have lived in the slum for a long time were accustomed to the lack of toilets as a state of existence in the informal settlements.

In addition to this lack of toilets, there is also no running water connection to the houses. This means that the few existing flushable toilets have to be flushed using a hand held bucket after making a trip to the nearest water source. Water is fetched from nearby taps or storage tanks at a fee. This is common practice and therefore makes the construction and use of latrines more popular because of the water scarcity and additional cost implications of using a flushable toilet.

Concerning the Fresh Life Toilets, there was a general perception that the toilets are cleaner and better maintained when they are run by the owners as opposed to when they are run by employees.

5.2 Questionnaire results

From the 40 questionnaires that were administered during this study, we found that before the introduction of the Fresh Life Toilets, 18 used pit latrines and the remaining half used eastern type toilets that are flushed using water in a bucket due to lack of piped or running water. The users are expected to bring their own water to use for flushing the toilet after use especially if the toilet has no charge attached to it. Many of those interviewed said that these toilet options were filthy. This had motivated the current Fresh Life Toilet users to embrace the cleaner option.

20 of the users of Fresh Life toilets who were interviewed have used the toilet for less than 6 months and the rest have used it for up to one year. 25 of the interviewed users are of the opinion that the toilets are a good sanitation option with cleanliness and lack of unpleasant smell being cited as the most popular reason for using the toilets. Besides cleanliness, the after sale services like provision of toilet paper, hand washing water and the presence of a mirror and a place to hang ones bags while using the toilet are a major selling point among the users of these toilets. The presence of instructions for use in every toilet was also applauded. Most users had nothing negative to say about the toilets, however those who did all had hygiene related concerns. Similarly, suggestions for improvement were also hygiene related. Other suggested improvements was the need to include a showering facility because they are also lacking in the Mukuru and to have solar lighting to illuminate the toilets at night in order to enhance the user's safety. Of all the interviewed users, 3 were children and their concern was increased privacy for the users by ensuring the structure was well sealed, especially in school settings. 67% of the users believed that the Fresh Life Toilet was the best sanitation solution for Mukuru. The remaining 33% were split between the latrine and working flushable toilets.

From the questionnaires administered to the non- users of Fresh Life toilets, cleanliness, cost of using the toilets and proximity to the toilet are the major deciding factors that influenced their choice of toilet facility. Those who lived in place with a clean, free and working toilet had not used the Fresh Life Toilets because of the cost of using a Fresh Life Toilet. 40% of the non-users interviewed cited lack of a Fresh Life Toilet in neighborhood as the reason for not using a Fresh Life Toilet. 90% of those interviewed knew about Fresh Life Toilets and thought

that were clean and have improved cleanliness in the neighborhood. One person who was new in Mukuru had never heard of the toilets and one respondent tried them once and gave up usage because the toilet was dirty. This is what she said, “I have heard that fresh Life toilets are clean, but the one time I tried using one, it was full of houseflies, I think I just had bad luck!”

The city council authorities, political leaders, the landlords and the ministry of health were cited as institutions that should ensure that sanitation needs within Mukuru are addressed. Most respondents thought that the landlords and the municipality should provide toilets for the residents of Mukuru.

Below are some percentage representations of the data collected through the questionnaires:

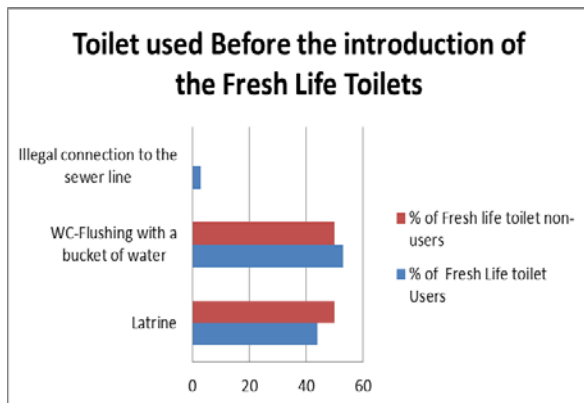


Figure 7: Previous toilets used

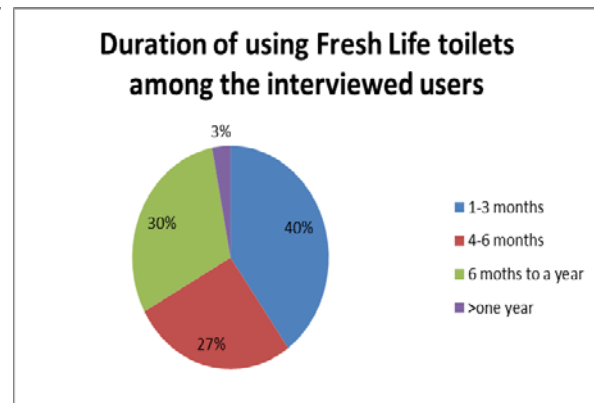


Figure 8: Duration of use

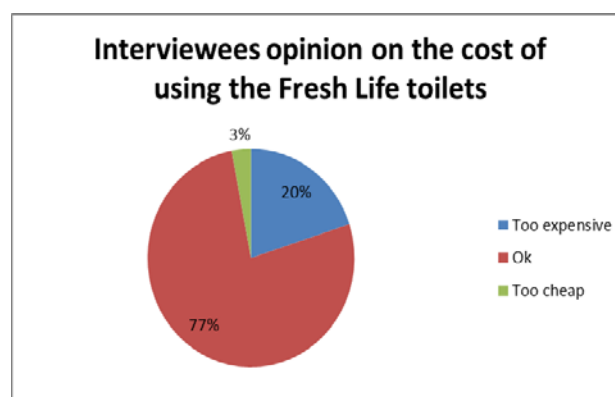


Figure 9: Users opinion of cost

5.3 Focus Group discussion results

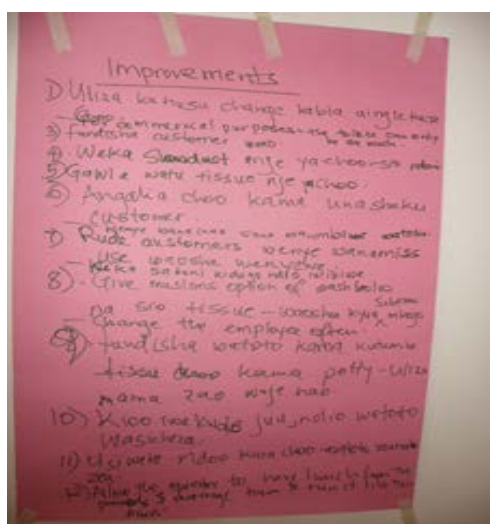
The Focus group discussion centered on the experiences of different Fresh Life Toilet owners running the toilets in different parts of Mukuru. The discussion was around the advantages, disadvantages and the process of running a Fresh Life toilet. The following table (Table 2) offers the basic information about the toilets that were represented at the focus group discussion. These demographics were recorded by the toilet operators in their business files as part of their daily business records.

Table2: Fresh Life Toilets basic information.

Name	Location	Type of Toilet*	How long have they had a toilet	How many customers per day? (Average number from their records)	Average customer distribution per day			
					Men	Women	Boys	Girls
Owner of toilet 1	Kwa Rueben	Commercial	Three months	64	24%	23%	25%	26%
Owner of toilet 2	Kwa Rueben	Commercial	One year	102	32%	35%	16%	17%
Owner of toilet 3	Kwa Rueben	School	Four Months	70				
Owner of toilet 4	Kwa Rueben	Commercial	Six months	34	53%	36%	6%	5%
Owner of toilet 5	Viwandani	Commercial	Five months	75	No records*	No records*	No records*	No records*
Owner of toilet 6	Kwa Njenga	Residential	Seven Months	60	No records*	No records*	No records*	No records*
Owner of toilet 7	Kwa Njenga	Commercial	Seven Months	92	53%	34%	6.5%	6.5%

*Unlike the rest of the toilets represented on this table, the operators of these toilets do not keep records of their customers. This was discovered after the Focus group discussion and was not possible to hold another focus group discussion to substitute them.

The focus group discussion among the Fresh Life Toilet owners produced data that explains the workings of a Fresh Life toilet and its accompanying benefits and challenges. This are tabulated in the table below and loosely classified into themes.



The Focus Group discussion participants and feedback; Pictures by Likoko (2013)

Table 3: Results from Focus Group Discussion

Feedback Categories	Themes	Responses from the discussion
Advantages	Income and employment	The toilets are a source of income for slum dwellers and provide meaningful employment for many.
	Cleanliness	Daily waste collection means clean and odorless toilets
	Fresh Life Toilet concept and Design	The whole system of waste management by Sanergy makes it easy to run the toilet. The marketing launch by Sanergy during installation attracts customers. No need for a drainage system. Design makes it easy to clean. It can be located anywhere because it does not smell.
	Sanitation Benefits for the neighborhood	The toilets can be located anywhere hence their proximity has provided a toilet solution reduce the incidence faeces in the neighborhood.
Challenges	Running Costs	Toilets have 'high' running costs to function properly- sawdust, hand washing water and soap. The operators work hours are too long per day for them to accommodate all the customers.
	Poverty	Many slum dwellers cannot afford the small fee charged to use the toilet while some pay half price.
	Community Behavior	Some toilet users can use the toilet incorrectly as they fear appearing ignorant by asking how it works. Improper use is a big challenge that soils the toilets making it difficult to clean them. Misuse and theft of the soap, water and sawdust causes losses. Rudeness and vandalism by some users, refusal to pay after use and parents sending small children to use the toilets unattended.
	Donor Mentality	Some community members assume the toilets should be free because they were initiated by expatriates who should cater for the cost of using the toilets.
	Cultural barriers	Those with cultures that advocate for use of water to clean oneself after toilet use shun the compost toilet.
	Related Insecurity	Unruly drunkards and manning the toilet at night can present a security challenge for the toilet operator.
	Design	The toilets set up in waterlogged areas get the barrel chamber flooded in the rainy season. The proximity of Fresh life toilets to each other is bad for business
Areas that need Improvement	Toilet design	Modified to accommodate small children easily, toilets installed in waterlogged areas should waterproof the base to prevent flooding of the chamber with the urine and faeces barrels.
	Community education and Involvement	The community should be taught about the toilets and its proper use at every available platform and opportunity since most of the challenges have to do with not understanding how the toilet works. There is a need to find a way to accommodate those whose culture insists on the use of water after visiting the toilet.
	Cost	There is need for a solution that will allow the poor to use the toilet without compromising the franchise idea that allows the toilet to generate income for slum dwellers. The cost of setting up a toilet is high for the slum residents hence even with a busy toilet; one may have to only one toilet causing customers to queue as they wait for their turn to use the toilet.

5.4 In-depth interview results

A total of 12 interviews with chosen informants from the Sanergy staff team and a government representative were conducted and were tape recorded. The following is a recording analysis of the interviews that captures the issues that are relevant to our research question.

5.4.1 Marketing team

The two members of the marketing team who were interviewed said that the Sanergy sales and marketing began before the Fresh Life toilets were set up in Mukuru with an initial focus on highlight the gap in sanitation and then followed by beginning the toilet installations. It has 2 sections namely consumer marketing and branding. These are support services for the toilet owners who run the toilets as a franchise and to create awareness and increase toilet usage. They also focus on getting new Fresh Life Toilet owners so as to increase the number of

toilets in Mukuru in a bid to provide decent sanitation to the whole of the slum area. This is done through having community events to launch new toilets and holding entertainment rallies for sanitation awareness in order to highlight the sanitation challenges in the community to teach people in different parts of Mukuru how to use the Fresh Life Toilets. The organization is called Sanergy but the Fresh Life Toilet is the Organization's brand that allows people to identify with the toilets. The marketing team aims to meet the sanitation needs of the community by providing a dignified sanitation option in the slum at an affordable price which allows the toilet owners to be able to run the toilets and achieve an overall improved sanitation on the community. The marketing team also assesses the areas to determine the most effective awareness creation activity, scout for wall branding opportunities, carry out market storming exercises, distribute fliers and put up posters. Field staff members don branded t-shirts to raise brand awareness. There is a deliberate effort to achieve brand success by providing high levels of cleanliness, professionalism, well designed toilets, and training the operators to be competent.

The team conducts trainings for the owners of toilets to equip them with marketing skills and the basics of running a business successfully. There are quarterly meeting for all the Fresh Life Toilet owners to share ideas and a small team of owners and the marketing team meet to brainstorm different aspects of the fresh Life toilets on a monthly basis. The team uses factors like number of sales of new toilets, number of participants in their public awareness creation for to assess their impact in the community. They also seek to find out why people use or not use the different toilets in order to increase toilet usage by addressing these issues in the marketing strategy.



Picture 1: Sanergy marketing team demonstrates hand washing during an awareness creation day.

Picture2: Wall branding using The Fresh Life Toilet brand logo

Picture 3: Marketing team launching new toilet

Pictures by Sanergy

5.4.2 Construction team

The construction team has installed about 200 toilets since they began in 2011. The process has been dynamic with several design and material changes aimed at getting the best final product for Mukuru. The basic concept of the toilet design remains the same but it is modified to solve different problems. The toilet is made of different prefabricated parts that are assembled at the toilet location site and made out of locally available material. The prefabrication is done by three different departments; wood work, cement work and metal works. One toilet takes two days to build the parts in the molds but it takes 14 days to be ready to be installed. A list of the materials and where they are sourced from is available in the Appendix. This makes it possible to move the toilet from one location when the need arises. The design takes into account the fact that Nairobi is water logged and has changed the design to keep the water from the chamber. The toilet is designed to last for about 5-10 years with necessary renovations especially for the doors and repainting. Mukuru residents inquire about the possibility of them building the toilets in their rural homes when the team is installing the toilets in the community.

The two members of the construction team who were interviewed said that the team experiences challenges in installation because the area has a haphazard network of piped water connections and waterlogged soils that complicate the installation process. The materials and design has changed over time to address breakages of the parts that cause waste of material.



Pictures: The construction of different parts of Fresh Life Toilets; Pictures by Likoko (2013)

5.4.3 Field Officers

The main role for the field officers is to visit all the Fresh Life Toilets once a week to check the overall state of the toilet, to collect the daily business records kept for the toilets and find out and if the toilet owners have any challenges. This is to provide support to the toilets in order to improve hygiene standards and increase user numbers. The Fresh Life toilets run by the owners generally are better maintained and make more money than those run by employees. Most toilet operators are motivated run their toilets well and motivated by the income they make from the business. Some operators struggle initially or when they employ a new person, but they eventually catch up after being trained and with follow up. From the field experience of the field officers, the most important thing to run the Fresh Life Toilet successfully are keeping proper records, maintaining high levels of cleanliness and, the additional services things provided in a Fresh Life toilet is; hand washing water and soap, toilet paper.

Overall hygiene is the most important factor for Fresh Life toilet success. The common feedback is that the toilet has helped to make the environment clean and provided a dignified toilet option. The owners are able to provide all these comfortably from their profits. The toilets are located on the roadsides, residential spaces, a few in schools one in a church and one private toilet for a family. Most toilet owners own one toilet, however some owners have multiple Fresh Life Toilet units adjacent to each other which reduces the incidence of queuing and makes their customers more satisfied. The different toilet owners charge different prices depending on where the toilet is located and the price charged by the previously existing toilets. The price ranges from 3 to 5 Kenya shillings for adults and 2 to 3 shillings for children. Some toilets charge a standard fee for both children and adults.



Instructions for using a Fresh Life Toilet found in every Fresh Life Toilet; Picture by Likoko (2013)

5.4.4 Founder and Management

Sanergy's founders form part of its current management team. I interviewed one of them who said that the initial stages of setting up the organization included scouting for a suitable location to set up the organization, sourcing

for the material and translating the designs into molds followed. The third phase of the project included producing two toilets and set up one in Mukuru and one in Kibera slums to test the concept in practice.

The team then partnered with an existing non-governmental organization school located in Mukuru that was experiencing challenges in providing working toilets at the school and a youth group that had a biogas digester. This allowed Sanergy to start off without having to set up a waste processing plant in its initial trial stages. The school provided land to build and its population used the toilets as the Sanergy team did more planning and learnt the early lessons from the process of implementing compost toilets in Mukuru. The two factors made Mukuru an ideal location to set up base for the franchise toilet idea to work. Mukuru residents also have more income stability since they work in the industries surrounding that Kibera residence. Moreover, Mukuru being next to an industrial area made it easier to acquire waste processing permits and to get a big premise to set up construction sites and waste management sites.

Initial funding for Sanergy's activities was through awards from business plan competitions, grants and social investments from interested firms. Currently the organization is funded through bilateral grants, private foundation grants, prizes and through equity investment. The plan is for Sanergy to reach a self-sustaining state in two years' time, by increasing the number of toilets it has which will lead to an increase in the waste it produces and make it possible to supply bulk quantities of fertilizer which will generate income to run the waste management cycle, capital investments and operational costs. The success of Sanergy is based on getting as many users as possible by increasing the number of toilets installed. The plan is to be financially self-sustaining by 2015.

A majority of Mukuru residents have over the years grown accustomed to pay to use the toilet and have some form of income to enable them to pay. However, there is a plan to investigate the possibility of providing vouchers through philanthropy for those who cannot pay to use the toilets and eventually make the toilets a public good or have the government fund the voucher system. By March 2013, Sanergy had a staff of 95 people and 65% of them live in Mukuru slum. This is a deliberate recruitment that provides jobs for community members who are qualified and it is more practical since they already know the environment in which they work in making it easier to execute their tasks. The project has so far grown a lot while maintaining a high quality network. This focus on quality can slow down the progress of installing new toilets. About 8000 out of the 600,000 residents of Mukuru use Fresh Life Toilets on a daily basis. Hence there is still a lot of room for growth.

Besides maintaining the waste management cycle, Sanergy is constantly testing new ideas and trying out new ways of setting up Fresh Life toilets in order to work with the different community dynamics. One of the new ideas is converting traditional latrines which are full and no longer in use into fresh life toilets due to the space challenge in Mukuru.

5.4.5 Waste management team

Two Sanergy employees from the waste management team explained that once the construction team has installed a toilet and it is operational, the Sanergy waste collection and processing cycle begins at the Fresh Life toilet. The goal of waste collection is to use it as raw material for generating fertilizer, biogas and electricity. The waste is taken to the waste processing center in Mukuru and weighed for the purposes of record keeping and keeping track of the performance of the different Fresh life toilets. The sawdust used in the toilet by the users eliminates smell and makes it easy to handle the faeces. The faeces are mixed with sawdust and one third of the urine and allowed to sit in reconstructed boxes to decompose naturally for 3-4 months with frequent mixing for aeration. This process allows the pathogens to be naturally eliminated as the faeces turn into manure. To ensure the pathogen count is within the WHO standards so as to make it safe for growing food. Safety precautions are taken to protect the workers who directly handle the faeces from infections by minimizing contact with the raw faeces by provision of protective gear and providing necessary inoculation. The fertilizer can be custom made for different crops and depending on the market fertilizer needs by altering the ratio of urine in the manure to alter the acidity levels in the fertilizer. Farmers demand for huge quantities of fertilizer at a time hence Sanergy has halted the supply of fertilizer in the short term in order to build up its stock to meet the demands of large farms that want to use the fertilizer. The materials needed to generate fertilizer are locally sourced hence it is not an expensive process.

Sanergy collects approximately one part of faeces per every two parts of urine. The faeces are all used to make fertilizers and the excess urine is taken to the municipal sewage processing plant due to its strong odor, and the ratio of fertilizer it produces-approximately 5kg of urine fertilizer-struvite- for 1000 litres of urine. Research is being conducted on how to most cost effectively convert the urine into this fertilizer that is odourless and easy to handle. This will make it possible to utilize all the urine collected from the Fresh Life toilets to make fertilizer.

Sanergy has also used human faeces to generate biogas. Initial tests have been successful and the plan is to use the already generated biogas to provide the energy needed to produce more biogas. Although this process can be messy and even unsafe in other application, as it involves feeding human faeces into the biogas digester, Sanergy has minimized any manual handling through use of a pump. Tests are underway to allow for mass production of biogas. This biogas is what will then be used to generate power to feed into the national power grid. The process requires large quantities of human faeces to be a reality-approximately one thousand toilets are needed to sustain daily power generation realistically. Research is a constant on-going process in the Sanergy waste management cycle.



Pictures: (clockwise) 1. Transporting the Urine and Faeces from the toilets to processing center. 2. Weighing the urine and faeces when they arrive at the waste processing center. 3-4: Emptying the faeces and urine into the processing boxes, 5-6: Pictures: Fresh batches of faeces in processing boxes and the fertilizer maturing further in an open Space: Pictures by Likoko (2013)



Picture: Biogas production: Picture by Likoko (2013)

5.4.6 Fertilisera expert

As a person who has worked with fertilizer development at Sanergy since the initial stages, Sanergy's fertilizer expert said that Sanergy has produced and supplied 3 types of fertilizer into the market; the solid fertilizer made from a mixture of faeces and urine, struvite product made from urine and liquid fertilizer which is made from urine. The liquid fertilizer is ideal for crops that thrive on high acidity like coffee; the solid fertilizer is used for maize horticulture and vegetables. The fertilizer depends more on the type of farming and how they apply the fertilizer, for example flower farms prefer liquid fertilizer which is soluble and can be applied through their irrigation pipes.

The fertilizers are in the process of being tested in 6 different farms, in different locations, on different crops and in varying quantities to establish the best fertilizer for different yields. The trials are based on orders from farms that intend to plant with the fertilizer in 2013 in bulk, hence the need for the tests. The fertilizer testing is also slowed down by the fact that most of Kenyan farming is rain-fed hence the testing can only be done during long

or short rain period. The trials have also to wait for the plant cycle so that is applied on new crops. 450 tonnes of fertilizer has been processed at the Sanergy waste recycling center. Approximately 2 Tonnes of liquid fertilizer and 7 tonnes of solid fertilizer have been distributed and released to farmers for trial purposes. The solid fertilizer costs approximately 300 dollars per tonne and the liquid is about 0.25 of a dollar per litre.

The fertilizer quantity and quality is paramount to building a customer base, hence the focus is now to raise the product quantity so as to be able to deliver the quantities required to establish a tangible client base.

5.4.7 Interview with a government representative

I also carried out an interview with the government representative for Landimawe sub-location; who has partnered with the Sanergy team in the past. According to him, the government advocates for sanitation in Mukuru slums and partners with the ministry of Water and Sanitation to work in Mukuru. The official government policy is a campaign against open defecation and flying toilets. The Kenyan sanitation policy is embedded in the Kenya VION 2030 Plan and the Kenya Slum Upgrading Program (KENSUP) which is line with the 7th millennium development goals to “halve by 2015, the proportion of people who do not have access to basic sanitation.” The government plan is to bring a new focus of basic infrastructure provision, such as water and sanitation, as an entry point to slum upgrading (KENSUP 2008:23).

A few places in the slum have also been supplied with sewer lines. There are also plans to develop a sewage network and making water channels to supply the slum with running water. However, the community questions the realization of this program due to political interference witnessed in the past by politicians who want to keep the slums as they give them many votes during elections. As a whole, the government has no activity in place to provide a sanitation solution for Mukuru. Most of the toilets in Mukuru have been put up by community based organizations as an income generating activity. The political leaders have also built some. There are also some that were put up by NGOs supported by the government.

The Sanergy approach is innovative and can be replicated in other places if lobbying is done with relevant ministries. The initial cost of setting up the toilet is too high and a disadvantage for Sanergy. The presence of other toilets in the community which are free was also identified as a possible hindrance for people to use the Fresh Life Toilets. However, the government representative pointed out that the toilets are not maintained or cleaned and are therefore unhygienic. An issue of concern for the government is the sustainability of the collection of waste from the toilets. Is the waste collection system foolproof, reliable and able to work in the long term? A former member of parliament had attempted to install a few compost toilets in the past but the project failed to failure in the waste collection system and no space for farming in Mukuru with the prepared manure.

6. Discussion

This study clearly shows that innovation and contextual relevance are vital for the implementation of ecological sanitation. The case study on ecological sanitation, visualizes how the concept has made significant strides in being implemented in the informal settlements. It also shows that despite the slum areas having poor hygiene standards and lacking in basic sanitation facilities over the years, the residents of Mukuru are fundamentally concerned about the state of sanitation in the slum and are keen to maintain high standards of hygiene. Financial sacrifices and long distances walked to access toilets are acceptable to the residents to ensure that individuals have access to hygienic toilets so as to avoid disease. 77% of those interviewed thought that it was acceptable to pay for the toilet services. Efforts to avail hygienic human excreta management plan are readily accepted by the community. The study points out cleanliness as the most important theme with regard to sanitation. A human excreta handling system cannot be referred to as a sanitation solution if it fails to deliver on cleanliness. This ordinary sounding logic is not necessarily the reality in the slum contexts where the presence of a toilet is a luxury, extremely unhygienic toilets are a normal occurrence and access to a clean toilet is a privilege reserved for those with financial means. As seen from the non-users questionnaire results, an incidence of an unclean and housefly infested Fresh Life Toilet led the user to abandon the use of the toilets altogether. Regular cleaning per day is key to maintaining Fresh Life Toilets standards of cleanliness.

From the GIS maps from Map Kibera Trust, it is evident that the haphazard land use in this informal settlement is a source of communal sanitation nightmare. From the maps we can see that a lot of sanitation related facilities are used as landmarks and some of them are non-operational. Of particular interest are dumpsites and pee-points as identifiable landmarks from the maps. Conventional human waste management in the cities uses the sewer system and running water to remove the sewage from the different homes and neighborhoods, and has succeeded in maintaining hygiene in many parts of the world. Sanitation infrastructural improvements in the slum are faced with many bottlenecks that would necessitate the demolition of the entire slum for a sewer system to work; a

move that is neither realistic nor possible in the short term. There is an evident need to find other sanitation solutions that meet the community's sanitation needs in order to curb disease and have a clean environment for people to live in. This solution is necessary for all manner of human waste in the slum but especially for managing human excreta. It is interesting to note that several government, political and non-governmental sanitation initiatives have failed to conclusively address the sanitation challenge over the years despite the society expecting their assistance. This failure for the system to deal with the sanitation challenge evokes the question of "how to do it". It also represents a 'waste' of valuable resources that subsequent initiatives to address this challenge should avoid. We can also see a concentration of the abandoned and overflowing toilets units near the river that cuts across the slum, with open defecation and overflowing toilets, the river is contaminated heavily with human waste and other industrial wastes from the surrounding industrial activity. Therefore in its current state, the water resource in this river cannot be used to enhance Mukuru's sanitation. The contaminated river is a symptom of the underlying lack of waste management systems in the slums and other informal parts of the city. Sanergy can make use of the GIS maps generated by Map Kibera Trust to map out the different Fresh Life Toilets as they come up in Mukuru. This can be included in the overall Mukuru sanitation map to show areas where this improved and hygienic sanitation option can be accessed.

Sanergy has sought to come to grips with the issue of sustainable sanitation through the Fresh Life Toilets. The idea of a social enterprise with a branded franchise is new in this context. It is an innovative intervention strategy that takes into consideration the existing environmental, economic, social and cultural dynamics in the slums to establish a waste management system. Some of the unique informal settlement dynamics that Sanergy took into consideration in order to settle for the franchise business model include: the history of low long term success rates of free toilets due to lack of maintenance, the widespread lack of indoor toilets in many of the slum houses, the existing culture to pay for toilet use in the slum, the high unemployment rate in the country and most of all the frustration brought about by lack of clean toilet options in Mukuru and other slums. These factors set the stage for innovation to address a real societal need. The sanitation gap invited anyone who could do it to step in and work towards providing answers.

The comprehensive initial research conducted by the founders of Sanergy was a valuable investment into the development of the project. This culture of interrogating different available options is still at work in Sanergy. An example is the ongoing research on urine based fertilizer that will allow Sanergy to use all the urine in production of fertilizer. Research is valuable to the process of development and it allows for mistakes to be made in a smaller scale until the idea is ready to be implemented in the larger sphere.

The study also shows that adaptation of new technology takes time. Despite Sanergy being in operation in the slum for almost 2 years, most of the interviewed people have used it for an average of 8 months. The coordinated approach by Sanergy seeks to introduce new toilets, ensure the toilets provide excellent service to the users to increase usage of the toilet, which in turn will lead to increased fertilizer, biogas and -eventually-electricity production. For this strategy to work all aspects of the toilets need to work well. As seen in the interviews, failure to keep the toilets clean causes a drop in the number of users and causes a negative ripple effect in the entire process. The deliberate marketing and increased distribution of the toilet has helped to increase use of the compost toilets. The Sanergy team has therefore identified this interrelated process as the leverage point that is the success of the ecological sanitation system. Hence all the activities in the organization are designed to enhance a healthy Sanergy system. However, it is clear that all the parts of the Sanergy cycle need to grow so that the entire cycle can run sustainably-and the waste can support the generation of electricity as illustrated in the below diagram.

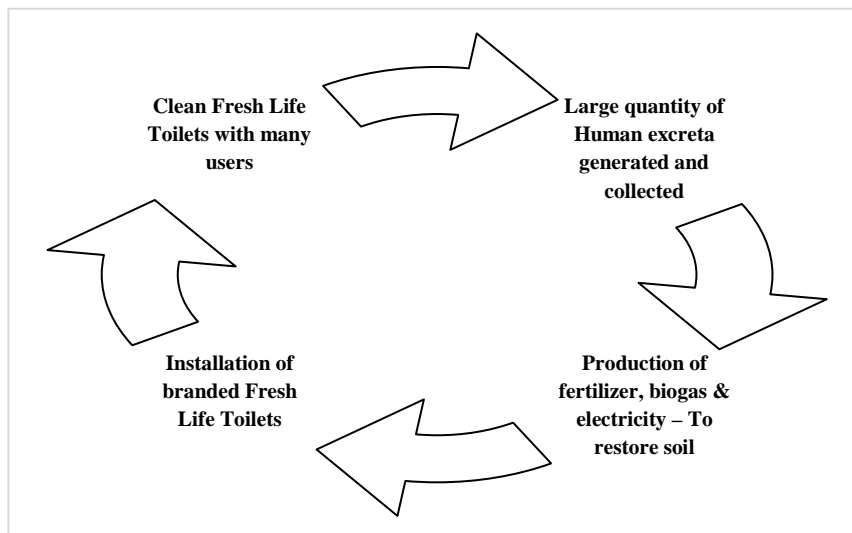


Figure 10: The Sanergy Waste cycle

Figure 10 depicts a system where different activities and objectives meet to obtain a common good and the whole ends up being greater than a sum of its parts as defined by systems theory (Bertalanffy 1969). The common good in the Sanergy example is the enhancing hygiene by providing a solution to managing human waste. Systems theory seeks to explain and understand phenomena as interrelated and as part of a diverse network that has boundaries between the different parts. In Sanergy's case, the different parts include the toilet installation, toilet maintenance, waste collection, and fertilizer production. These parts pass on different products to each other as suggested in von Bertalanffy's book (Bertalanffy 1969). Looking at Sanergy as a system is one of the ways of interpreting its activities and understanding it as a whole. Constant research conducted on the processes and products of the different parts, is useful in to keep the system healthy and to identify the sustainability gaps. The existing commitment to research at Sanergy is commendable and has already contributed to better service delivery by improving design and making the waste management process more efficient. Research on the fertilizer produced has led to improved and varied types of fertilizer being produced.

This study also brings out the irony of basic advantages that are glaringly unavailable to residents of informal settlements. This portrays a socially unequal society and undermines the achievement of sustainable development as a concept that champions for social equity. The politics of criminal toilets based on illegal toilet connections to main sewer lines, the privilege of using tissue paper in the slums and the reality of raw excreta in the backyard are some of the things one has to deal with in informal settlements sanitation strategies.

An important question that this study seeks to answer is "Is there room for sustainability in human excreta management?" A look at the waste management cycle through the lenses of the principles of sustainable development begins to answer this question. As seen in the previous studies conducted on ecological sanitation in the literature review section (pg4), sustainability can be evaluated based on futurity, the physical environment, societal equity and public participation. The question is how are these scientific principles visible in practice? Unlike the previously used pit latrines and open defecation in bushes and dumpsites, Fresh Life Toilets protect the environment from raw sewage and subsequent health challenges. It also adds value to the environment by keeping it clean and the fertilizer manufactured restores nutrients to the soil thus making it good for the physical environment. This is bound to improve the overall environment in future especially with an increase in the toilets in the slums and the number of toilet users in Mukuru and other slums. The production of biogas and the eventual production of electricity or the national power grid is an investment in clean air that is good for the environment in all aspects. Furthermore, the materials used to construct the toilets are locally sourced in the surrounding industrial area. This reduces the amount of secondary emissions related to the construction of the toilets. However, a proper life cycle analysis would have to be conducted in a different study to verify the amount of emissions associated with the materials used to construct a Fresh Life Toilet.

As seen in the background information, Mukuru is an area with scarce resources and limited access to water making it harder to harness the existing resources as they are almost fully depleted. Sustainable development strategies here have to be grounded on innovation so as to remain true to the spirit of sustainability. In light of climate change and the increase in water scarcity levels, the compost toilets idea works well as it uses the little water available to enhance hygiene by ensuring all toilet users wash their hands while eliminating the need for

large quantities of water to flush toilets. This enhances sustainability in the slum as it also ensures the minimal land resource is not used to build a sewer plant but is used to naturally generate fertilizer. In this context, the compost toilet has brought about a realistically applicable toilet and human waste management solution.

The franchise idea is a non-conventional idea of involving the public in Sanergy's goal. As opposed to setting up toilets and employing the toilet operators, Sanergy's franchise idea ensures high commitment levels from the toilet operators who are committed to earn an income without having to deal with the waste from the toilets and toilet maintenance. The users of the toilet also have vested interests in the toilets as they view it as a solution for their lack of clean toilets for many years. The cost of setting up the toilet is however too high for regular slum dwellers hence this erodes the basis of arguing that the toilets encourage public involvement. Mitchell (1995) refers to these sustainability arguments as weak sustainability. However, Sanergy's partnership with microfinance organizations is making it possible for more people to own the latrines and be part of the franchise network. The Fresh Life Toilets also display the last principle of sustainability-social equity- through providing a clean and decent toilet option-with the accompanying after sale services-for slum dwellers who had been relegated to overflowing, unhygienic, and poorly maintained toilet units-which still costs a few shillings to use. The new toilets are providing clean toilets which have lacked for many years to the Mukuru residents. The cost of accessing a Fresh Life Toilet however erodes some of the novelty of the toilets meeting the social equity principle of sustainability. This can be seen from the interview responses where there is some price related tension as some consumers want it cheaper and some operators want to increase their cost especially in areas where they charge less. On the other hand, the commitment to regular public sanitation campaigns as a marketing tool for Sanergy is a strong indicator for sustainability because it is an investment in educating Mukuru residents. As one of the interviewees put it, "It has brought education to the village!"

Based on the interview with the government, the general lack of government run sanitation systems in Mukuru is an issue of concern. However as seen in the introduction to this study, this is not an issue that is unique to Mukuru, it is common in all other slums across the world. Despite the illegality of informal settlements, the slum dwellers as taxpaying citizens qualify to receive public services from the government at a subsidized rate just like residents of other neighborhoods. The Kenya slum upgrading program in conjunction with the country's vision 2030 provides an overall vision that needs to be translated into implementable plans that have funding and personnel attached to them. This way, the government can participate in the management of human excreta in partnership with the private and non-governmental actors in Mukuru. The Sanergy concept can be developed further and the government can provide the infrastructure and support the realization of ecological sanitation in various forms in the different parts of the world.

Unique findings of this study include the widely accepted notion in the slum that one has to pay to visit the toilet. Though not celebrated by the residents of Mukuru, it is an accepted arrangement to pay before visiting the toilet in the slum. The irony is that slum dwellers usually are not as financially endowed as the rest of the population who get to visit the toilets in their houses and work places for 'free'. The forces of supply and demand stepped in to supply toilets as they were missing in the slum neighborhoods for a long time. The desire for all to have a clean toilet facility justifies the cost for the users. As seen in the principles of sustainable development, social equity is a key component of sustainable development; hence as long as the cost of accessing the toilet prevents people from using this sanitation option, the Fresh Life Toilets will not achieve an all-round strong sustainability status. Sustainability and social equity go hand in hand. Sanergy's toilet voucher system that depends on philanthropic donations is an example of enhancing the sustainability of the Fresh life toilets by increasing social sustainability. This voucher system is still at the investigative phase. The government slum upgrading plan is a possible avenue for partnering by provision of "toilet access subsidies" to ensure that social equity is increased as more people get enabled to access the toilets. Sanergy has also employed majority of its staff from the slum and the Fresh life toilets owners also live in the slum. The local owners and staff members are another indicator of public involvement in Sanergy's project. The rich understanding of the culture and slum dynamics by the staff members and toilet owners has contributed to the project's acceptability and success rate in the project.

The location of the commercial toilets along the roads needs to be carefully considered in order to not undermine the sanitation principles by locating the Fresh Life Toilets near road side food kiosks and make shift hotels, as this would be an oxymoron. When asked which other toilet would be ideal for the slum context in the interviews, the respondents cited the flushable toilets and the clean pit latrines as alternatives. Weighing those two toilet options against the Fresh life toilets, points back to the question of sustainability. Which one is sustainable? As seen before, sustainability can only be defined in relation to a specific context. In Mukuru, there is minimal sewer system and running water coverage. Installing flushable toilets for the population of 600,000 would be a structurally and economically monumental task. With the present statistics and dynamics of Mukuru, this is neither viable nor sustainable. The pit latrines on the other hand work well, if cleanliness is observed. However

they present a challenge since once they are full, new ones have to be dug in a new location or the old one emptied. Lack of sewage collection trucks and a poor road network in the slum makes it impossible to get trucks into the slums to empty the toilets therefore the toilets are emptied unhygienically using buckets. This is a common challenge with the high population and hence the pit latrines are not a viable long term option for the Mukuru context. Moreover getting land to build new latrines when old ones are full is a challenge in the high density informal settlement. Therefore based on these realities, the Fresh Life Toilet provides a more realistic and long term solution that is friendly to the environment as it conserves water, eliminates pollution and restores the soil nutrient content without using a lot of space as the toilets do not get full and abandoned.

It is interesting to note that the number of children visiting the toilets as indicated by the records from the different sampled toilets is significantly lower than that of adults. With the background information we have, it is safe to conclude that the children either go to the bushes or use the pre-existing toilets with their inherent problems. This can be attributed to lack of income to have them access the toilets; which means that children have a higher disposition to disease and a toilet solution has to provide an accessible option for it to be adopted.

Other recommendations for improving the design of the toilets include having a design where the toilet user does not see the waste in the barrels while using the toilet. The tropical weather in Nairobi can cause toilet odor and encourage the presence of flies in the toilet that are very busy and prone to be full by the end of the day and a solution for this is necessary especially because of the high value that users attach to the 'Fresh Life Toilet experience'.

Previous research on ecological sanitation has looked at ecological sanitation in both rural and urban contexts in the developed and developing countries. Just like in the earlier studies, contextually relevant and adapted ecological sanitation models seem to work in practice in different parts of the world; this study also shows that the same is true for the Mukuru context. The basic idea of the compost toilets in all the researches is similar. The conclusion is that ecological sanitation has been tested in different contexts and it works if adapted to suit the setting. Adaptation ranges from the process, to the products, to the toilet design and the community training.

This study is unique because unlike previous studies it analyzes the workings of ecological sanitation when implemented as a social enterprise in an informal urban settlement. The business model is different and presents new challenges and adaptation strategies. Unlike in previous research, this study reveals a clear progression plan for the ecological sanitation implementation plan from its inception to when it attains self-sustaining state.

As it often happens in empirical studies, this one too has a few weaknesses that need to be mentioned. One of the weaknesses is due to the organized focus group meeting. An ideal focus group discussion should have 6-8 participants in order to ensure that everyone gets a chance to actively participate in the discussion and different perspectives are represented in the group (Amoakohene 2004:29). In order to have the right number, we invited 12 people to cater for any last minute disappointments. However we only had 5 members show up on the scheduled day and had to organize for in depth interviews with the missing members in order to get their valuable input. It was also not possible to see crops under cultivation using the Sanergy fertilizer because this research was done during the driest month of the year as the farmers are preparing their land for the long rains and planting season. A similar study conducted in future should take the farming seasons into consideration in order to examine the plants grown using Sanergy's fertilizer. The farmers were also unavailable to be interviewed, therefore we substituted and interviewed the Sanergy fertilizer and farm trials expert and got the necessary information. These changes in the data collection plan had an impact on the findings of our study as the study got little information about the farmers' perceptions and opinions on the fertilizer. Lastly, this being a qualitative research meant that the sample size was relatively small; hence we cannot make many general conclusions as the findings are context specific.

Despite the above challenges, the results from this study can be trusted, first because the empirical research methodology was decided upon after a sound literature review had been conducted on the subject of ecological sanitation as shown in the literature review section. This guided the formulation of the research questions and the interview questionnaires. The empirical data was collected using a variety of interdisciplinary methods like interviews, focus group discussions and participant observation. These methods provided insight into the realities of sanitation in Mukuru. They also made it possible to prod and ask supporting questions to clarify the responses received. All these provided different insights into the case under study and valuable qualitative and quantitative data to complement the secondary data on ecological sanitation implementation. This study also had a low nonresponse rate; therefore we were able to get most of the needed primary data. In-depth interviews made it possible to get in depth information through further probing. Deliberate effort to interview respondents with

different demographics and at different locations in the slums was made in order to get a divergent feedback and eliminate a potential homogeneity caused by interviewing residents at only one part of the slum

The questions for this study were also designed to capture the interdisciplinary nature of the study topic. The use of a camera and voice recorders during the interviews and the focus group discussions made it possible to accurately capture the feedback and be able to listen to it again and again to extract useful information. I was also able to focus on the interviews as opposed to trying to write as the interviewee was talking. Open ended questions made the interviews and the questionnaires capture different aspects of useful qualitative and quantitative information and other instruments used were also designed to capture the different data types from different target groups. Different lenses were used in this study to better understand and interpret the Sanitation situation in Mukuru.

Language was also an added advantage for my empirical research as I was able to speak the three languages needed to carry out research with the different people being interviewed. Having spent a lot of time in slum settings I was also able to focus on the research and not experience culture shock. The context specific approach used in this study can be used to draw comparisons between ecological sanitation in Mukuru and other slums in Kenya and other parts of the world.

Based on the four principles of sustainability, this study of this waste management design has revealed that the Sanergy project has strong sustainability with regards to the first two principles; concern and enhancement of the environment and improving the environment for the future generations. Significant levels of public participation have been achieved. However, the social equity principle of sustainability has an overall weak sustainability. It presents opportunities to come up with innovative ways to sustain the working franchise concept while providing access to Fresh Life toilets for all the residents of Mukuru. The purpose of this study was to assess Sanergy's initiative as an ecological solution to the sanitation challenge in Mukuru slum. Through the use of different methodological tools we have been able to see that the, Fresh Life Toilet compost toilet initiative is an ecological sanitation solution that is implementable in Mukuru slum. This study demonstrates management of human excreta sustainably to enhance proper sanitation in an urban informal settlement. Through coordinated efforts and guided by sustainable development principles, human excreta can be managed effectively not only in urban informal settlements, but also in other areas in Kenya and other water scarce areas.

7. Conclusion

Informal settlements should not be condemned to filthy neighborhoods which lack sanitation facilities. Research and implementation of best sanitation practices in different parts of the world can be galvanized to address the sanitation needs in slum neighborhoods and other places that need sanitation solutions. There are many ecological sanitation options in use around the world. "Ecological sanitation (EcoSan) is a systemic approach and an attitude; single technologies are only means to an end and may range from near-natural waste water treatment techniques to compost toilets, simple household installations to complex, mainly decentralized systems" (Langergraber & Elke Muellegger 2004).

In an era where climate change and the depletion of resources are fast becoming a reality in many parts of the world, we have to bear in mind the need for resource conservation as we spearhead different developmental activities. Sustainable development provides us with the template to facilitate resource conservation and enhance sustainability in all our spheres of influence. The provision of human excreta management services is not an exception. Hence the focus on sustainable development should be multi-faceted, multi-sectoral and with multiple interests. Managing human excreta in a way that is sustainable has to be good for the society, good for all aspects of the environment and good for future users of the resources in the environment. This ensures that there are working ecosystems and socioeconomic systems in all parts of the society .This will in turn cause a ripple effect that will lead to increased social equity.

Mukuru and other informal settlements can provide a platform for launching a new 'toilet revolution' that can rival and even surpass the flushable toilets. This is because ecological sanitation which is embodied in the Fresh Life Toilet concept is pro-environment and supports water conservation. The design of compost toilets can be modified to suit the different housing areas to a point where compost toilets become the norm. In cities like Nairobi where running water is intermittent, this can provide a solution for lack of water, provide a safeguard against the future water scarcity and conserve the available water instead of flushing it down the toilets. Similarly, adapting the ecological sanitation idea will ensure that the soil nutrient uptake and input become a closed loop system which is good for food production, food security and the ecosystem as a whole. Informal

settlements therefore provide an opportunity to set up sustainable systems of waste management from scratch and based on ecological sanitation principles.

In conclusion, good sanitation should not be a privilege of a select few or groups in society, but a right for all. Hence working toilet facilities and a supporting waste management system should be accessible to the whole society regardless of the dispositions of the various members of society. Ecological sanitation through the use of compost toilets provides a viable and contextually relevant sanitation solution that ensures informal settlements residents are provided for with decent toilet facilities. Through this study, this basic technology that uses natural processes has been proven to work in a dense sub-Saharan African context. This presents a possibility for other places with similar challenges to adopt this technology. As this concept is applied to different settings, it becomes more and more defined till it gets accepted as common practice. The recycle and reuse principles inherent in ecological sanitation help point towards strong sustainability in any context. This is necessary to adopt in this day where global resources are highly strained and sustainability needs to be encouraged. Sustainable development is therefore not an end in itself but a means to an end. It has the potential to create a harmony between man and nature that is mutually beneficial to all interactions in the ecosystem.

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9. Appendix

Appendix 1: Questionnaires used For Data Collection

INTERVIEW QUESTIONNAIRES

1. Questions for Sanergy Organization Leadership team

This questionnaire is a part of a case study that seeks to assess Sanergy's Fresh Life Toilet initiative as an Ecological sanitation solution in Mukuru slum in Nairobi Kenya. This case study is a part of a Master of Science thesis project in Sustainable Development.

Interviewer _____

Interviewee _____

- a) Give a brief historic background Of Sanergy?
- b) How did you start the Sanergy venture?
- c) Why did you set up in Mukuru?
- d) What type of organization is Sanergy? (Eg. NGO or Business venture)
- e) What factors made you settle establishing Sanergy as a Franchising model?
- f) How did you finance this project initially?
- g) Where is the project now? How many owners/ Operators of the fresh life toilets do you have? How many units have been installed so far?
- h) In light of Sanergy's goal of providing a decent sanitation option to Mukuru slum, what consideration is given to those who cannot afford to pay?
- i) How is Sanergy funded now and how does it look like in future?
- j) How does the organization staffing look like?
- k) How many of your employees are from Mukuru? From Without?
- l) How do you deem the success of this project?
- m) What are the challenges that you experience in fulfilling the Sanergy vision?
- n) Can this model be replicated?
- o) In your opinion, what will it take to replicate it?
- p) Can this be a mainstream sanitation solution in Kenya?
- q) What will it take to achieve this

2. Questions for Users of Sanergy Fresh life toilets.

This questionnaire is a part of a case study that seeks to assess Sanergy's Fresh Life Toilet initiative as an Ecological sanitation solution in Mukuru slum in Nairobi Kenya. This case study is a part of a Master of Science thesis project in Sustainable Development.

Interviewer: _____

Interviewee residential area: _____

Sex of person being interviewed Male _____ Female _____

- a) What system did you use to relieve yourself before you started using the **Fresh life toilets**?
- b) How long have you been using the **Fresh life toilets**?
- c) What do you think of the **Fresh life toilets**?
- d) What do you think about the cost of using a **Fresh life toilet**?
- e) What do you like about the **Fresh life toilets**?
- f) What don't you like about the **Fresh life toilets**?
- g) What would you like to improve in the **Fresh life toilets**?
- h) Are there better solutions to this problem? Who should solve it?

3. Questions for Non-users of Sanergy Fresh life toilets.

This questionnaire is a part of a case study that seeks to assess Sanergy's Fresh Life Toilet initiative as an Ecological sanitation solution in Mukuru slum in Nairobi Kenya. This case study is a part of a Master of Science thesis project in Sustainable Development.

Interviewer: _____

Interviewee residential area: _____

Sex of person being interviewed Male Female

- a) Where do you normally relieve yourself?
- b) Have you heard of the Fresh life toilets?
- c) Why don't you use a Fresh Life Toilet facility?
- d) What do you think of the **Fresh life toilets**?
- e) What would make you use a Fresh life toilet?
- i) Are there better solutions to this problem? Who should solve it?

4. Questions for Operators/Owners

This questionnaire is a part of a case study that seeks to assess Sanergy's Fresh Life Toilet initiative as an Ecological sanitation solution in Mukuru slum in Nairobi Kenya. This case study is a part of a Master of Science thesis project in Sustainable Development.

Note: These questions are designed to be administered in a Focus group discussion with the operators of the Fresh life toilets. An additional tabular sheet for collecting quantitative information from the informants will also be used to complement the discussions.

Interviewer_____

- a) Are you an owner or an operator of Fresh life toilet?
- b) What are the advantages of being a fresh life owner/operator?
- c) What are the disadvantages of being a fresh life owner/operator?
- d) What do you like about the **Fresh life toilets**?
- e) What don't you like about the **Fresh life toilets**?
- f) What would you like to improve in the **Fresh life toilets**?
- g) Are there better solutions to the toilet problem in Mukuru? Who should solve it?

5. Questions for Stakeholders- Users of Fertilizers.

This questionnaire is a part of a case study that seeks to assess Sanergy's Fresh Life Toilet initiative as an Ecological sanitation solution in Mukuru slum in Nairobi Kenya. This case study is a part of a Master of Science thesis project in Sustainable Development.

Name of user_____

Location_____

- a) Which Sanergy fertilizer product do you use?
- b) On what crops have you used the fertilizer?
- c) How long have you used Sanergy's fertilizer(s)?
- d) What quantity of the fertilizer have you used?
- e) How can you describe the fertilizer? Is it user friendly?
- f) What do you think about the price of the fertilizer? (Compare the price to the quality of the fertilizer and to other types of fertilizers in the market.)
- g) Have you harvested any on the crops you planted using Sanergy's fertilizer?

- h) How has Sanergy's fertilizer affected your crop yields? Explain your answer.
- i) What do you like about Sanergy's project fertilizer?
- j) What don't you like about Sanergy's fertilizer?
- k) What would you like to improve in Sanergy's fertilizer?
- l) Do you have any additional comment(s) concerning the fertilizer, its use or its effect on crops?

6. Questions for Government representative –Local Government representative/ Ministry of Public health and sanitation

This questionnaire is a part of a case study that seeks to assess Sanergy's Fresh Life Toilet initiative as an Ecological sanitation solution in Mukuru slum in Nairobi Kenya. This case study is a part of a Master of Science thesis project in Sustainable Development.

Position (Title) _____

- a) What is the government policy on Human excreta management in the slums?
- b) What does the government do to manage Human Excreta disposal in Mukuru kwa Njenga (and other slums)?
- c) Are there any specific government plans to manage the human excreta disposal in Mukuru and other slums?
- d) Do you know about the Fresh Life Ecological Sanitation project run by Sanergy?
- e) What do you think about it?
- f) What are the advantages of the **Fresh life toilets** for Mukuru?
- g) What are the disadvantages of the **Fresh life toilets** for Mukuru?
- h) What would you like to improve in the **Fresh life toilets**?
- i) Are there better solutions/policies to this problem? Who should solve it?

7. Questions for Sanergy Organization's Field workers

This questionnaire is a part of a case study that seeks to assess Sanergy's Fresh Life Toilet initiative as an Ecological sanitation solution in Mukuru slum in Nairobi Kenya. This case study is a part of a Master of Science thesis project in Sustainable Development.

- a) What is your role in Sanergy?
- b) In which part of Mukuru do you work? (Viwandani, Kwa Reuben, Kwa Njenga) What are the names of the zones in your areas of operation?
- c) How often do you interact with the Fresh life operators/ users and the fresh life toilets?
- d) How many toilets do you have in Mukuru?
- e) Are the Fresh Life toilet operators capable of running the Fresh life toilets effectively in the absence of your visits?
- f) What is needed for Fresh life toilets to run successfully?
- g) Where are the Fresh life toilets located in Mukuru? E.g. in a residential plot, private use, school, church etc.

8. Questions for Fresh Life Toilet Construction team.

This questionnaire is a part of a case study that seeks to assess Sanergy's Fresh Life Toilet initiative as an Ecological sanitation solution in Mukuru slum in Nairobi Kenya. This case study is a part of a Master of Science thesis project in Sustainable Development.

- a) What materials do you use in construction?
- b) Where do you get the materials from?
- c) How long does it take to build one toilet? Do you have to be a professional to build one?
- d) Can the cost of building a Fresh Life Toilet be cheaper?
- e) What are the good things about this toilet?
- f) What are the challenges of this toilet?

Appendix 2: Fresh Life Toilet construction Materials.

Table showing the materials used to construct and install a Fresh Life Toilet and where the material is sourced from:

No.	MATERIAL	LOCATION SOURCED FROM
1	Chicken wire	River road*
2	Cement	Arthi River
3	Paints	Enterprise road*
4	Round Bar	Lusaka road*
5	Machine Screws	Mombasa road*
6	Clear hose pipe (one inch)	Dar es Salaam Road*
7	High Erly strength Cement	Lusaka road*
8	Eco plate	Embakasi road*
9	Nails	Lusaka road*
10	Roofing Nails	Gikomba
11	Block boards	“
12	Bolts and nuts	“
13	Ply wood	“
14	Conta adhesive	“
15	Panal professional wood glue	“
16	6ply boards	“
17	Door Hinges	
18	Corrugated fibre Iron Sheets	Sakwa road
19	Deep timber	Lusaka road
20	Super drum	Kamukunji
21	Roof kit timber	Imara daima

*** Locations are found in Nairobi Kenya. Most of them are located in the Industrial area Close to Mukuru.**

Appendix 3: Responses from the non-users of Fresh Life Toilets

RESPONSES FROM NON-USERS OF THE FRESH LIFE TOILETS INTERVIEWED IN MUKURU SLUM, NAIROBI								
Questions	1	2	3	4	5	6	7	8
Respondents	Residence	Sex	Previous toilet	Knowledge of Fresh Life Toilets	Why don't you use?	What do you think of the toilets?	What would make you use one	Are there Better solutions? Who should provide the solution
1	1	2	1	1	Expensive	Clean	If it is free	Latrine is better, landlord should provide toilets
2	1	2	2	1	dirty, have houseflies	dirty, can cause infections	If it is housefly free	The WC that you flush with a bucket, Landlord
3	3	2	1	1	have a good toilet where I live, no need	I don't know much about it	If I need to use the toilet and one is near	Latrine, Landlord
4	3	2	1	1	costs money- so I used the free dirty one where I live	attractive, clean	If it has no houseflies	City council
5	1	1	1	1	none where I live	no smell, conveniently located	If I need to use the toilet and one I near	The local political leader
6	3	1	2	2	We have a toilet	I don't know about them	I don't know	flushable toilets, the city council
7	1	1	2	1	We have a toilet	they are a good concept	no need for water	City council
8	2	1	1	1	none where I live	well designed, cleanliness standards	if other toilets are dirty with overflowing raw sewage, proximity to one	None
9	1	1	1	1	none where I live	good; promote good health and neighbourhood cleanliness	proximity to my house	None-This is the first project with a working toilet solution
10	2	1	2	1	none where I live	they are good	I don't know	None
Coding Guide	Residence	Sex	Previous toilet	Knowledge of Fresh Life Toilets	Why don't you use?	What do you think of the toilets?	What would make you use one	Are there Better solutions? Who should provide the solution
	1=KwaReuben	1=Male	1= Latrine	1=Yes	Themes	Themes	Themes	Themes
	2=KwaNjenga	2=Female	2=WC- Flushing with a bucket of water	2=No				
	3=Viwandani		3= Illegal connection to the sewer line					

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Appendix 4: Responses from Users of Fresh Life Toilets in Mukuru

RESPONSES FROM USERS OF FRESH LIFE TOILETS IN MUKURU SLUM, NAIROBI										
Questions	1	2	3	4	5	6	7	8	9	10
Respondents	Residence	Sex	Previous toilet	Duration of use	Opinion	Cost	Advantages	Disadvantages	Improvements	Other Solutions better than Fresh Life toilet. Who should do it?
1	1	2	1	1	1	2	No, smell, mirror, clean	None	Other students peep through the spaces at the door, long queue in school toilet	None
2	1	2	2	3	1	2	clean-use disinfectant, no smell, new concept like use of sawdust, no need of water for flushing,	The toilet design makes it easy for urine to splash and cause infection, not child friendly,	To always keep the toilet clean	None
3	1	2	2	3	1	2	very clean	None	None	None
4	1	2	1	3	2	1	next to hawking premises, solved a problem that had been there for long	Dirty at times if not cleaned regularly, the tissue paper is unhygienically stored, hand washing water is not very clean. busy toilet can smell at times.	cleanliness standards, deeper hole,	The WC is better, landlords should provide toilet options for tenants
5	1	2	1	3	1	2	clean, no smell, proximity to work place	None	Find a way to get rid of the flies	A sewer line to make flushable toilets possible
6	1	2	2	2	1	2	clean, no smell, easy to use, good service from the toilet operators	Poor lighting at night	Use solar lighting, include a showering solution	None
7	1	2	3	1	1	2	No smell, spacious, clean, provides toilet paper.	None	None	None
8	1	2	2	3	1	3	Dry and hygienic floor, clean, no smell, has a place to hang one's bag, provides tissue, provides soap and water for hand washing, has a mirror,	None	Include good scents in the toilets	None
9	1	1	2	2	2	2	proximity, provide water for hand washing	Some are located near hotels-not hygienic	None	The landlord should provide toilet solutions for tenants.
10	3	2	1	2	1	2	clean, easy access	None	More fresh life toilets to cover the whole slum	The WC is better
11	3	2	2	1	1	2	clean, provides water for hand washing provides tissue paper	None	None	None
12	3	2	1	1	1	2	No smell, clean, provides toilet paper.	None	Provide disinfecting soap instead of regular soap.	None

13	3	1	1	3	1	2	no smell, well built, good colour	None	Regular cleaning,, regular painting and repair of toilets	None
14	3	1	1	3	1	2	no smell, easy to clean, small children can use*,spacious	None	Other students peep through the spaces at the door, long queue in school toilet	None
15	2	1	2	3	1	2	Waste separation, mirror	None	None	The city council should provide toilets for residents
16	1	1	2	2	1	2	Clean	None	None	None
17	2	1	1	1	1	2	proximity,	can have a bad smell at times	Use air fresheners	None
18	2	1	1	1	1	1	well maintained, comfortable, clean	None	None	none, the area political leader should address the sanitation issue
19	1	1	1	3	3	2	good management, clean, good design, good waste disposal system	flies, some are not well managed	spray regularly to get rid of flies, there is space on the doors hence there is risk of being seen	Not the city council because they do a bad job anyone who can do a good job
20	2	1	2	3	1	2	has made the neighborhood clean	None	None	None
21	1	1	1	1	1	2	they give tissue paper and not newspapers, the provision or hand washing	None	None	None
22	1	1	1	2	1	1	Promote cleanliness, no queues, has provided a solution.	None	None	The area political leader should provide sanitation solutions
23	2	1	1	1	1	1	clean, well, built, attractive, frequent emptying of urine and faeces barrels	Some lack soap and water for hand washing	None	The Slum community leader should provide sanitation solutions
24	2	1	2	1	1	2	has created employment in the slums, re-use of waste, has brought education to the slum	can be dirty	always have hand washing water and soap	The ministry of Health and the landlord should provide sanitation options.
25	1	1	1	1	1	1	Provides tissue paper, the use of sawdust, the hand washing idea.	None	clean the toilet with soap always, pay the people who work there to motivate them to clean, don't have women in charge of toilets because they can focus too much on petty issues	None
26	2	1	2	2	1	2	Clean, the waste separation and collection concept.	None	None	Landlords should fix it.
27	3	1	1	1	1	2	Flexibility in where is can be located, it has instruction, provides hand washing soap	None	Install more toilets	none
28	1	1	2	4	1	2	clean, mirror,	it has no shower	add a shower facility	The mobile toilets are better
29	2	2	1	2	1	2	Clean	None	None	None

30	2	1	2	2	2	2	clean, has a place to hang your bag	None	None	None
Coding Guide	Residence	Sex	Previous toilet	Duration of use	Opinion	Cost	Advantages	Disadvantages	Improvements	Other Solutions better than Fresh Life toilet. Who should do it?
	1= Kwa Reuben	1=Male	1= Latrine	1=1-3 months	1=Good	1= Too expensive	Themes	Themes	Themes	
	2=Kwa Njenga	2=Female	2=WC-Flushing with a bucket of water	2=4-6 months	2=Average	2= Ok				
	3=Viwandani		3= Illegal connection to the sewer line	3=6 months to a year	3=Bad	3= Too cheap				
				4=>one year						
Notes:										
			long distance to toilet is common		Several =excellent	Should be 3 Kshs.	*designed for a school			
			distance to the latrine was very far, had to leave businesses premise to go to the latrine		good only if kept clean					

Appendix 5: Tabulated comparison of data from users and non-users of Fresh Life Toilets

Residence	% of Fresh Life Toilet Users	% of Fresh Life Toilet non-users	Sex	% of Fresh Life Toilet Users	% of Fresh Life Toilet non-users	Previous toilet used	% of Fresh Life Toilet Users	% of Fresh Life Toilet non-users	Fresh Life Toilet Users	Duration of use	Opinion	Fresh Life Toilet Users	Cost	Fresh Life Toilet Users t
Kwa Reuben	19	5	Male	18	6	Latrine	13	5	1-3 months	12	Good	25	Too expensive	6
kwa Njenga	6	2	Female	12	4	WC- Flushing with a bucket of water	16	5	4-6 months	8	Average	3	Ok	23
Viwandani	5	3	Total	30	10	Illegal connection to the sewer line	1	0	6 months to a year	9	Bad	2	Too cheap	1
Total	30	10				Total	30	10	>one year	1	Total	30	Total	30
									Total	30				
PERCENTAGE REPRESENTATION OF DATA COLLECTED FROM USERS OF THE FRESH LIFE TOILETS														
Residence	% of Fresh Life Toilet Users	% of Fresh Life Toilet non-users	Sex	% of Fresh Life Toilet Users	% of Fresh Life Toilet non-users	Previous toilet used	% of Fresh Life Toilet Users	% of Fresh Life Toilet non-users	Fresh Life Toilet Users	Duration of use	Opinion	Fresh Life Toilet Users	Cost	Fresh Life Toilet Users
Kwa Reuben	63	50	Male	60	60	Latrine	44	50	1-3 months	40	Good	83	Too expensive	77
Kwa Njenga	20	20	Female	40	40	WC- Flushing with a bucket of water	53	50	4-6 months	27	Average	10	Ok	20
Viwandani	17	30	Total	100	100	Illegal connection to the sewer line	3	0	6 months to a year	30	Bad	7	Too cheap	3
Total	100	100				Total	100	5	>one year	3	Total	100	Total	100
									Total	100				