Landscape Analysis and Business Model Assessment in Fecal Sludge Management:

Extraction and Transportation Models in Africa

Nigeria Study Report

BY

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EXECUTIVE SUMMARY

Background and Objectives

In Nigeria, inadequate collection and disposal of fecal sludge has become the major source of ground and surface water pollution, with significant negative environmental, public health, social and economic impacts. To better understand the status of septic sludge management policy and practice in Nigeria, an assessment of landscape analysis and business model of fecal sludge management in the country has been undertaken. The assessment has been carried out in Nation's three cities, viz. Abuja- the capital of Nigeria, Ibadan- the largest and populous capital of Oyo State, and Yenagoa- a small emerging coastal city in Bayelsa State in the Niger Delta Region. The objectives were to assess the amount of fecal sludge generated in the selected cities through toilets and septic tanks, the collection and disposal practices by the communities and fecal sludge emptiers (both manual and mechanical operators), their problems, constraints in sustainable operations and to develop a business model so as to make the fecal management a viable proposition in urban centers in Nigeria. Data was collected between March and September 2011 and was sponsored by Bill and Melinda Gates Foundation.

Methodology

A desk review was carried out on the fecal sludge management (FSM) at national and global levels, which showed that there is dearth of information in most of the African countries and particularly in Nigeria. Fecal sludge emanating from on-site toilets and septic tanks is being indiscriminately removed and dumped into nearby bush or into streams and rivers. This has resulted in outbreaks of cholera and other gastrointestinal diseases affecting the communities with poor sanitary practices who are often the poor, children and women.

The FSM survey is a cross-sectional case study involving 3 cities: Abuja, Ibadan and Yenagoa. Standardized methodology adopted at Addis Ababa by four other African countries (Burkina

Faso, Ethiopia, Kenya and Senegal) was adopted for the survey in each of the three cities. A multi-stage stratified sampling technique was adopted for the selection of households interviewed to ensure even distribution across socio-economic strata of the cities. The first stage was the stratification of each city into municipal and rural local governments followed by stratification into administrative/political districts/wards/localities as clearly identified by the federal and state governments. The third stage was the selection from each of these cities, the municipal local governments and their districts/wards/localities for in-depth data collection in view of the guidelines in SOW. In the fourth stage, the localities or communities were stratified into principal residential densities: high density (low-income), medium density (middle income), and low density (high-income) to ensure that all types of toilet facilities in the cities were captured. Besides the community survey using questionnaire administration, participant observation, Focus Group Discussions, and Key Informant Interviews were carried out. Fecal sludge management facilities including types of toilets, disposal sites, and treatment plants/facilities were geo-referenced with the use of GPS while digital cameras were also used to take photographs. The survey instruments were designed and used to address the households who used the toilet facility, people involved in feces handling including collection or emptying, transportation and disposal (Private sector, Governmental Agency officials, and Institutions). Fecal sludge volume was determined based on the number of trips made by the evacuators and the volume of the truck in a year. Similar calculations were made for manual evacuators. Data was analyzed using descriptive and inferential statistical methods using SPSS and satellite mapping.

Results and Main Observations

The demographic characteristics of the cities are as follows: In Abuja, the number of households per house varied between 1-5 (78.6%) and 6-10 (16.1%). The household family size varied between 1-28 with a mean of 3.76. Some 44% of the respondents were the owners of the houses and tenants constituted 54%. Up to 55.2% of the respondents had education at tertiary level and up to 30.6% had up to secondary level. A sizeable number (37.7%) were Civil servants while 25.5% were traders. About 54.1% owned cars and some 10.2% owned

motorcycles. The most common cooking fuel is kerosene (61.2%). In Ibadan city, the mean number of households in the houses was 4.66±3.71 with a minimum of one and a maximum of 30 households. Also, the mean number of persons living in the house was 17.94±13.3 with a minimum of one and a maximum of 120 persons. Majority (71.5%) of the respondents was household heads and 77.5% also owned the houses. Some 32.6% and 21.7% of the respondents had secondary and tertiary education respectively. Major occupation of the respondents was trading (46.1%) and only 6.1% were in the civil service. A very high percentage (70.1%) had no means of personal transportation. A majority (84.6%) use kerosene for their cooking needs. In Yenagoa city, the mean number of households in the houses was 3.71±3.44 with a minimum of one and a maximum of 24 households. The mean number of persons living in the house was 13.1±9.2 with a minimum of two and a maximum of 60 persons. Majority (67.8%) of the respondents was household heads and 63.6% also owned the houses where the interview took place; 45.1% and 33.3% of the respondents had secondary and tertiary education respectively. Major occupation was trading (36.0%) and 27.7% were in the civil service. A very high percentage (70.9%) did not have personal means of transportation. For energy needs, 86.4% used kerosene.

Water supply in the three cities indicated as follows- in Abuja 34.4% of the respondents used pipe-borne water and 27.5, 15.4, and 22.7% relied on boreholes, wells and water vendors, respectively. In Ibadan, 67.5% obtain their drinking water from wells and other sources include pipe borne water (15.6%), boreholes (14.5%) springs (0.6%) and water vendors (0.6%). In Yenagoa, 61.4% obtain their drinking water from boreholes, and other sources include pipe borne water (8.7%) and water vendors (29.9%). Pipe borne water is also from borehole supply only. The amount paid for water supply ranged from USD 3.33 to USD 120 per month with a mean of USD 27.3.

Sanitation facilities in Abuja showed that 29.6 and 70.4% had off-site (connected to the sewer) and on-site facilities respectively. The available sanitation technologiesindicate that 29.6% of the households interviewed were connected to the central sewer. This is in line with the information obtained from Abuja Environmental Protection Board (AEPB), that only 30% of the

city is connected to the central sewer. Nevertheless, 43.2% of the respondents used individual septic tanks while 24.8% used latrines (traditional and VIP).

In Ibadan,use of pit latrines (51%), and septic tanks (47.10%) are common. However, only 0.5% of the respondents used VIP latrines and the rest connected to drains which discharge into the streams. In Yenagoa, septic tanks (89.4%), VIP latrines (9.5%) and very small proportion use pit latrines (1.1%).

While solid waste management is taken care of by the Ministry of Environment or Waste Management Authorities in all the three cities through the private sector, fecal sludge did not attract these agencies adequately. Only some private operators take care of the waste and are guided by the state regulations.

Flow of money charts for the three cities was worked out for the mechanical and manual operators. The mechanical operators are grouped into small (with one truck) and medium (4 to 5 trucks) scale operators based on the number of trucks being used. While the Fecal Sludge operators collect the fee from clients (schools, industries, establishments and individuals), outflow is to the government, taxes, bank loans, public relations (police and other government officials), fuel and vehicle maintenance. Income and expenditure statements were computed from the information available. In Ibadan more manual emptiers are engaged (65.6%) as compared to Abuja (24% mechanical, 18.6% manual and others are connected to sewer) and Yenagoa (42.4% mechanical and 15.9% manual). The mechanical emptying costs the client almost double that of by manual emptiers. The frequency of emptying varied between once in a year to 3 or 4 years at times. In Yenagoa, the frequency is more often due to high water table and rains for most part of the year. Clients expressed their willingness to pay in the range of USD 3.3 to 100.0.

On the final disposal of fecal sludge, Abuja has a central sewerage system (at WUPA) though working at 30% design capacity where the emptiers discharge into manholes rather illegally. Ibadan has a dedicated fecal sludge treatment plant (at Sanyo supposed to be stabilization pond) but not functional due to several human and governance problems. This facility receives

an annual volume of 53,743m^3 of fecal sludge and other liquid special wastes. In Yenagoa, the trucks are emptied in a dedicated location directly into the bush/creek. The site is not regulated by any of the agencies. However, usage of the land is policed by the community that owns the land. The community charges the emptiers a disposal fee but there is no maintenance of the site. Direct reuse is not evident in any of the cities. However, indirect reuse is practiced for farming purposes along with other biodegradable wastes.

A market analysis survey was carried out in the three cities using the data on daily volume of fecal sludge emptied, frequency of emptying and the actual cost of the operations. The typical volume of the septic sludge in Abuja, Ibadan and Yenagoa are 22, 18 and 14 m^3; the typical volume of the pits were 9, 12 and 10m^3; and the total annual sludge production was 1,247,193; 1,829,663; and 218,022m^3. In Abuja, 77% of the septic tank evacuations are carried out by informal emptiers. In Ibadan, 96% of the septic tank evacuations are carried out by informal emptiers. In Yenagoa, all the fecal sludge collected by the informal emptiers goes to the bush or creek.

A truck gap analysis was made in Abuja, Ibadan and Yenagoa, respectively using two separate methods. Method 1 used a standardized formula provided by the study proponents and the Method 2 utilized the data points in Method 1 in addition to the FS generation per capita for both pits and septic tanks. The Method 1 indicated that: (a) average daily septic tank volume to be evacuated (m^3): 2989, 2729 and 533; average truck capacities in the three locations – 10.5, 6.4 and 10 m^3, average number of trips 4 in each location, and the number of trucks required are 72, 107 and 14 in the three cities and the number of private trucks available on ground for service are- 12, 5 and 6, respectively. Thus the truck gap is 60, 102, and 8 in the cities. Method 2 gave a Truck gap of 14 and 11 for Abuja and Ibadan and a surplus of 1 for Yenagoa.

The study further revealed that FS generated per capita (litres/day) - Pit was 1.66, 1.67 and 2.01; FS generated per capita (litres/day) - Septic tank 4.28, 1.49 and 2.76; and the total volume of Fecal Sludge emptied / year (m^3) 447,847, 341,178, and 77,719, respectively.

Two income statements are presented for the Abuja and Ibadan mechanical emptiers using two tax rate scenarios. Across the three cities, it was quite evident that the business owners had other businesses they were running and sewage evacuation was not their sole source of income. For the purpose of this study, it was assumed that the businesses were paying taxes on the profits generated. The business tax rate is 30% while VAT which is to be charged on sales of goods and services is a mandated 5%. In Abuja, all (Companies "A", "C" and "E") but one of the companies (Company "B") is profitable on a USD basis. It is interesting to note that similar to Company "C" in Ibadan providing services to households, company "B"' also has a truck with a capacity of 12m^3. This implies that for every 1.5 to 2 trips made by his competitors, he only makes one and still charges the same price charged by his competitors with smaller capacity trucks. In Ibadan, Companies "A", "B" and "C" all are profitable on a USD basis. The unit profit margin ranged from a low of 10 USD / trip for Company "C" to a high of 34 USD / trip for Company "B". The wide gap between unit profit margins was driven primarily by equipment and maintenance costs. In Yenagoa, all companies ("A", "C" and "D") are not profitable on a USD basis except for company "B". The profit (loss) margin ranged from -266 USD / trip to 19 USD / trip. Manual emptiers though showed negative profit due to equipment depreciation cost, in reality they make adequate business as they charge between USD 66 and 100 and their tools are crude. Over 80% of the O&M cost is allocated to the purchase of fuel and truck servicing / repairs. The current conditions for accessing loans from financial institutions are quite onerous with interest rates as high as 22% and loan periods as short as 6 months. A breakeven analysis was presented in each city with tax and pre VAT scenarios. Sensitivity and risk analysis were also worked out based on the age of the truck and capacity. The emptying business could generate more revenues for companies with smaller capacity trucks than with larger capacity trucks as they charge per trip while they pay tax based on volume emptied.

Based on the observations and analysis the following recommendations are made: (a) need for an established regulatory framework and enabling infrastructures in place, (b) the national environmental sanitation policy has to move from being a desktop paper document to being a living and practical document, (c) implementation of the FSM guidelines needs to be enforced by the responsible government agencies, (d) there needs to be an enabling environment for the

mechanical and manual operators to carry out services in a safe and business conducive environment, (e) adequate disposal facilities need to be constructed and in the wake of the current cholera epidemic in Ibadan, such measures are urgent and imperative, (f) the government agencies should ensure appropriate laws are enacted and enforced to make it mandatory for all mechanical and manual emptiers to register with the appropriate agencies. Knowing who the service providers are in-city is a building block towards building a joint working partnership between the public and private sectors, and (g) active monitoring of registered service providers by the government authorities will ensure compliance with the applicable laws and regulations for fecal sludge (excreta) management.

1.0 COUNTRY FSM BACKGROUND

Onsite sanitation systems are the most commonly employed, and typically the most sustainable option, in Sub-Saharan Africa (SSA). However, the prevailing conditions across the region is characterized by dysfunctional on-site sanitation systems, poorly maintained fecal sludge collection facilities, and few alternatives to disposing untreated or inadequately treated fecal sludge directly into the environment. The resource value of fecal sludge is widely recognized for a range of applications. Designing sanitation chains that effectively capture this value can provide a financial driver that enhances service at every step in the value chain, from the household-level user, to the final end-use (Eawag, 2011).

Figure 1 Geographical location of Nigeria

The most populous country in Africa, south of Sahara is the Federal Republic of Nigeria, located in West Africa (Figure 1). According to recent census there are approximately 150 million people living in 36 States and Federal Capital Territory. But up until 1999, there were fewer than 500 functional public toilets available, leaving people with no choice but to urinate and defecate in the streets. Nigeria is ranked 142nd position among 169 countries in the Human Development Index and the life expectancy is 48.4. The Gross National Income stood at USUSD 2,156. UNICEF estimates that about 60% of Nigerians lack access to sanitation.

A large percentage of the population in Nigeria relies on onsite sanitation systems such as septic tanks and pit latrines. Overall, 13 per cent of households use VIP latrines. Six per cent of households use a pit latrine with a slab (6 per cent rural and 5 per cent urban). Among households with a non-improved toilet facility, 26 per cent use facilities that are shared with other households (44 per cent urban and 16 per cent rural). Less than 1 per cent use a flush

toilet (not to sewer/septic tank/pit latrine). Overall, 32 per cent of households in Nigeria have no toilet facilities. This problem is more common in rural areas (42 per cent) than in urban areas (14 per cent).

In Nigeria, the Water, Sanitation and Hygiene (WASH) sector is faced with substantial policy, institutional and financial challenges. Water and sanitation has not been the federal government's top priorities, although Nigeria has a comprehensive water and sanitation policy in place. Safe excreta disposal is not any institution's primary responsibility, and hygiene remains an afterthought. Many states do not have WASH policies. The linkages between the Federal Ministry of Agriculture and Water Resources (FMAWR) – responsible for WASH programs - and State Ministries of Water Resources, Environment, and Health are weak. Problems across states include poor functionality, badly-designed tariff structures and underfunding of software such as community mobilization, sanitation and hygiene promotion, and operations and maintenance activities to support hardware facilities installed (WaterAid, 2009).

Water and sanitation services have been devolved to Local Government Agencies (LGAs) in every state. LGAs are solely responsible for ensuring access and use of these services. However, lack of autonomy, budget limitations; and poor capacity, have hampered their ability to carry out these duties effectively. The LGA WASH units particularly in donor-assisted states, tasked with management and implementation of various projects, are dynamic, energetic and display a higher capacity to deliver quality services than those LGAs with no donor driven projects. Civil society participation is limited and sector capacity is weak. Competing resource demands, partly caused by the consolidation of government ministries, has led to underfunding of water and sanitation in Nigeria (WaterAid, 2009).

The management of onsite sanitation remains a neglected component of urban sanitation and wastewater management. Fecal sludge is the end product of onsite sanitation systems such as septic tanks and latrines, and is one of the most prevalent and least addressed forms of sanitation in the country. Inadequate management of fecal sludge has become the major

source of ground and surface water pollution, with significant environmental, public health, social and economic impacts. To better understand the status of septic sludge management policy and practice in Nigeria, there is an urgent need to conduct a rapid assessment of landscape analysis and business model of fecal sludge management in the country.

2.0 METHODOLOGY

2.1 Literature Review

Globally, every day, about 500 million Kg of human feces are generated in urban areas and about 600 million Kg in rural areas, producing a total of over one million tons per day. Most of this biodegradable organic material is disposed of with very little or no treatment. This highly dangerous substance is polluting water and soil and also has become a source of a variety of infections. In developing countries the situation of sanitation is rather poor.

The volume, composition and consistency of the excreta produced depend upon diet, climate, occupation and state of health of the people. The excreta is very complex physically, chemically and biologically. A typical composition is given (Box 1) by Bindeshwar Pathak (1990), the Founder and Honorary Advisor of Sulabh International, an International NGO which has promoted nightsoil digesters and various excreta disposal technologies in India and abroad. Egbunwe (1980) reported that in Eastern Nigeria, the amount of excreta generated is about 500 – 900 g per person per day. Generally, active adults eating high fibre diet and living in a rural area produce more feces. The amount of urine varies between 0.6 to 1.1 litres per person per day and is often mixed with feces or discharged separately.

Box 1. Chemical Composition of Excreta

(Results expressed on % dry basis)

Volatile solids	70.0
Cellulose	34.5
Hemi-cellulose	6.0
Crude protein	19.0
Crude fat (Lipids)	14.0
Ash	34.0
C/N Ratio	4.5

The types of toilets which are common in low-income communities are Pit latrine, VIP latrine, Twin Pit latrine, Compost toilet, Pour-flush toilet, Septic tank and soakaway, Aqua privy, Bucket

latrine, Vault toilet, and sewerage system (Sizelove, 1976; Cairncross, 1987; Morgan, 1990). These are further grouped as wet and dry systems. Pit latrines are the commonest and cheapest and when the pit fills to two-thirds volume, it is filled in with earth and a new pit is dug nearby. VIP latrines are better versions where the problems of odour and fly breeding are reduced.

A further improvement to the VIP latrine is the pour-flush pit latrine. If the pan is well designed it holds only 1.5 litres of water, it can be flushed by hand. Using 2 pits are often advised. The water seal eliminates the fly and odor problems. If the soil conditions do not allow the liquids (urine and flushing water) to soak into the ground from the pit, a pour-flush toilet may still be feasible. In this situation, it should discharge into a septic tank and from there to a sewer. Recent studies also showed the development of compost toilets and they are referred as "Dry Box latrine" or "Ecological Sanitation". A large volume of information is available on the use of these in certain parts of China, India and southern America. Here, urine is separated and the feces is covered with ordinary wood ash from the kitchen. The results are encouraging even though cultural barriers do no permit in some communities (Esrey et al, 1998; Uno Winblad, 1999, Personal communication, and also Dialogue on Diarrhoea, No.57, June-August, pp, 5-6). The dry sludge is devoid of helminths and is a source of manure for backyard gardens.

In many communities in Nigeria, the level of awareness to own or use toilet is increasing. The popular types are pit (including traditional), VIP and septic tank systems. Community Led Total Sanitation (CLTS) is also catching up; whereby many communities plan their toilets and encourage others to do. Pilot scale approaches are made in some States. However, the disposal of fecal sludge is still a problem and neither the government nor the communities are putting in sufficient efforts (Sridhar, 2008).

The Ibadan "Comfort Stations"

"Ibadan Comfort Stations" project was a joint programme among the State Government, World Health Organization, and the United Nations Development Programme. They originally planned to complete 500 units over a period of 10 years to cover the city's inner core areas distributed

in 14 wards. Of these, the government provided 25 as demonstration units and the rest were built by the communities through "self-help" programmes. Unfortunately, only 17 more were built (totaling 42) by the target period essentially through State Government's participation and none were built by the community participation. However, the government was generous in handing over the units to the agreed communities using certain criteria. The remaining were provided subsequently, even though it took about ten years.

All the existing 42 Comfort Stations are grouped into categories: Type I (serving 1250 people), II (serving 880), III (serving 400), and IV (serving 250) depending on the population served. They were constructed between 1972 to 1988. Each Unit has aqua privy system for excreta disposal (182.8 cm deep and with toilet seats ranging from 10 to 28 depending on the Type), bath/shower rooms (ranged from 6 to 16), and a wash room for washing clothes. There were water taps, overhead tanks, and electricity supply. They were all functioning at start. Used water was to be recycled for flushing the toilets. The emptying of the sludge was mostly manual and managed by the communities.

In recent years, several privately owned public toilet facilities in the city have proved good patronage as the users "pay and use" the facility. Typical examples are found in Bodija market, Ayeye, Aleshiloye, and other areas. A woman in one of the markets initiated a toilet facility and her revenue was ₦5 (user fee in 1990s) per person and about 300 people use the facility every day (Sridhar and Edamaku, 1999). The user fee is now stands at ₦ 20 per person. In all these facilities, importance is given for toilet facility as a revenue generating venture and none cared for the management of the final sludge. The sludge is emptied and buried in the vicinity. Various types of toilets and their designs are documented (Oluwande et al, 2008).

Fecal Sludge Disposal in Escravos

In Escravos, an island based oil exploration camp, fecal waste disposal is a serious problem. Currently, the sewage is being treated with lime and disposed into a creek in Warri, Delta State (Table 1; Fig. 2). A treatment plant was proposed capable of handling 30,000m^3 of

sludge/sewage, using a digester, stabilization pond and sand filtration which is expected to bring out a pollutant-reduction rate of <95%. It is yet to be constructed (Coker et al, 2003).

Table 1 Composition of Fecal Sludge at Escravos

Parameters	08/03/07 Ote/Sw/01
pH	7.47
Turbidity, NTU	243.00
Total Dissolve Solids (TDS) mg/L	4140
Dissolved Oxygen, mg/L	1.02
Biochemical Oxygen Demand (BOD) mg/L	9.5
Chemical Oxygen Demand (COD),mg/L	23.42
Total Suspended Solids (TSS) mg/L	497.00
Conductivity, µs/Cm	8530
Salinity, mg/L	246.66
Color, PtCo	Dark Brown
Carbonate, mg/L	<0.01
Sulphate, mg/L	63.08
Phosphate, mg/L	4.32

Figure 2 Fecal sludge management using lime (Sridhar 2010)

Excreta Disposal in Lagos

For decades, the Carter bridge end of the Lagos Harbour served as a disposal site for untreated human excreta, mainly through the use of organized collection of the pail system. In 1986, a law was promulgated (Elimination of Pail Latrine Edict of 1986) to stop this practice. Unfortunately, in spite of the banning of the pail system, sludge from the pit latrines and septic tank tanks still go to the Lagos Lagoon. Lagos Lagoon supplies edible fish to Lagos people and neighbourhood.

High water table makes the operation of cesspit system difficult in Lagos and the pits have to be emptied often. More recently, the Lagos Waste Management Authority (LAWMA) has procured a fleet of septic tank evacuators and the collection system is being organized through evacuation and disposal in a dedicated landfill. There are state laws to back up the management system.

Excreta disposal in Federal Capital Territory (Abuja)

In Abuja and neighbourhood, about 30% of the residential areas are served with underground sewerage system. The remaining are served by on-site sanitation systems including Pit toilets, VIP toilets, and septic tank systems. Both mechanical and manual evacuations are practiced. The evacuated sludge is disposed into sewer manholes or thrown/buried onto the bush.

Excreta Disposal in Other State Capitals

While the basic excreta disposal facilities are common in many states, the disposal patterns are limited to land application or disposing into watercourses. In Kano, the excreta is evacuated and spread on open land until the farming season. However, the disposal is crude and unhygienic with odor and fly problems. In Kaduna, the evacuated feces is disposed of in the bush, river or sent to refuse dump sites. In Yenagoa (about 40%) and other riverine areas the populations use the river and most of the toilets are built on the river.

2.1.1 Overview of Water and Sanitation Policies in Nigeria

It is recognized that of the more than 280 million children under five living in households without access to improved sanitation facilities, almost two thirds live in South Asia (106 million) and sub-Saharan Africa (75 million). Nigeria and the Democratic Republic of Congo contain most of the region's water and sanitation deprived people. A survey of sanitation coverage in 2004, as a part of MDGs progress indicated that Nigeria had an urban coverage of 53 per cent and rural coverage of 36 per cent and had a long way to reach the MDG targets. According to several MDG assessment reports, it is very unlikely Nigeria will attain its sanitation

targets by 2015. Over the past decade, several water supply and sanitation policies (Table 2) have been drafted with some eventually being approved at the federal level. The National Environmental Sanitation Policy of 2005 is the most recent and it specifically addresses excreta and sewage management. Unfortunately, the implementation and monitoring of these various policies has not been successful and neither has it been widespread at the state and local government levels. Highlighted below are a few of the policies and their key components.

Table 2 Sanitation Policies in Nigeria

Policy Document	**Enacting Institution**	**Targets**
National Water Supply and Sanitation Policy (2000)	Federal Ministry of Water Resources	(i) The initial target is to meet the national economic target of improving service coverage from 40% to 60% by the year 2003. (ii) Extension of service coverage to 80% of the population by the year 2007. (iii) Extension of service coverage to 100% of the population in the year 2011. (iv) Sustain 100% full coverage of water supply, sanitation and wastewater services for the growing population beyond the year2011.
National Water Sanitation Policy (2004 draft)	Federal Ministry of Water Resources	Targets include: (a) Review and improve coverage of sanitation to 60% of the population by 2007. (b) Extension of sanitation coverage to 65% by 2010. (c.) Extension of sanitation coverage to 80% by 2015. (d) Extension of Sanitation coverage to 90% by 2020. (e) Achieve 100% Sanitation coverage by 2025. (f) Sustain 100% Sanitation coverage beyond 2025.

National Environmental Sanitation Policy[1] (2005)	Federal Ministry of Environment	(a) Enact all relevant legislation required for policy implementation by 2005. (b) Increase access to toilet facilities by 25% in public places and 50% in households by 2006; and 75% and 100% respectively by 2010. (c) Increase sanitary management of sewage and excreta by 25% in 2006 and 75% in 2010. (d) Institute School Sanitation Programmes in 50% of schools by 2006 and 100% by 2010 (e) Extend present water supply and wastewater services coverage to 80% of the population by 2007, 100% by 2011 and to sustain full coverage beyond 2011. (f) Increase private sector participation in Environmental Sanitation services delivery by 20% in 2006 and 75% by 2010. Programmes and innovations to be implemented by the government in line with the above include the following: (a) House- to- House Sanitary Inspection (b) Monthly Environmental Sanitation Day and (c) Establishment of Mobile Environmental Sanitation Courts.

2.1.2 Pit / Septic Tank Emptying and Transportation

Of the above policies, the National Environmental Sanitation Policy (NESP) approved in 2005, seems to be the only one which specifically addresses excreta and sewage management. Unfortunately, as is the case with most policies instituted in Nigeria, implementation and enforcement of NESP has been rather dismal since its enactment over six (6) years ago. Emptying of pit latrines and septic tanks is carried out either manually or mechanically and

[1] *NESP covers: solid waste; medical waste management; excreta and sewage management; food sanitation; sanitary inspection of premises; market and abattoir management; adequate potable water supply; school sanitation; pest and vector control; management of urban drainage; control of reared and stay animals; disposal of the dead (man and animals); weed and vegetation control and hygiene education and promotion.*

mostly by private sector SMEs. The customer (either a household or an industry) pays the service provider to empty and dispose of the fecal sludge on site. These are the prevalent practices in Africa and Asia. The manual method of evacuation exposes both the service provider and the customer to the environmental hazards associated with coming into contact with human feces. Available literature on the types of emptying and transportation technologies available and used in Nigeria is currently lacking. That notwithstanding, the following commentary below is based on literature describing the prevalent technologies available in the developing world.

2.1.3 Human Powered Evacuation and Conveyance Technologies

The manual emptying process in Nigeria involves laborers, buckets, shovels and gloves and is used primarily for pit latrines. The fecal sludge in the pit is scooped out from the pit into a conveyance using shovels. Forms of conveyance include metal or plastic drums in push carts. The excreta is then conveyed to a convenient disposal site (legal or illegal) and the contents are dumped. Examples of disposal sites include municipal solid waste sites, open drains, channels for rivers / streams, open land and fields located close-by.

2.1.4 Motorized Emptying and Conveyance Technologies

The mechanical emptying process in Nigeria involves a mechanical (motorized) vacuum truck or a vehicle equipped with a mechanical pump and a storage tank for emptying and transporting fecal sludge and is used primarily to evacuate septic tanks.

2.2. Situational Analysis Methodology

(i) Study Design

The FSM study in Nigeria is a cross-sectional case study research involving 3 cities: Abuja, Ibadan and Yenagoa. The same methodology was adopted for the FSM survey in each of the three cities. A multi-stage stratified sampling technique was adopted for the selection of households interviewed to ensure even distribution across socio-economic areas of the cities. The first stage was the stratification of each city into municipal and rural local governments

followed by stratification into administrative/political districts/wards/localities as clearly identified by the federal and state governments. The third stage was the selection from each of these cities, the municipal local governments and their districts/wards/localities for in-depth data collection in view of the guideline in SOW. In the fourth stage, the localities or communities were stratified into principal residential densities: high density (low-income), medium density (middle income), and low density (high-income) to ensure that all types of toilet facilities in the cities were captured.

(ii) Types and Sources of Data

Both primary and secondary data were collected in all the three cities. While secondary data were essentially from desk review and collection of relevant documents from government agencies and organized private fecal sludge operators, primary data were collected through questionnaire administration, participant observation, Focus Group Discussions (with community representatives in the case of Ibadan), and Key Informant Interviews. Fecal sludge management facilities including types of toilets, disposal sites, and treatment plants/facilities were geo-referenced with the use of GPS while digital cameras were also used to take photographs. The survey instruments were designed and used to address the households who used the toilet facility, people involved in feces handling including collection or emptying, transportation and disposal (e.g. Private sector, Governmental Agency officials, Institutions etc.). The study involved the following tasks:

- Advocacy and sensitization in sampled communities;
- Household and Facility Survey using structured questionnaire;
- Focal Group Discussions (FGD) using FGD guide;
- Key Informant Interview (KII) using interview guide, and
- Observation using observation checklist.

(iii) Sampling Procedure

Balloting technique was used to select the localities/communities that were sampled in each city. In the case of Ibadan, as shown in Table 7 and Figure 5, there are 100 localities in the five Ibadan metropolitan local government areas according to the 1991 national population census

out of which 50% was sampled. The list of all the 50 localities (50% of total) sampled was compiled on the basis of their residential densities or socio-economic group as well as the local government area each belonged to. There are 37% high density (low-income) residential localities, 45% medium density (middle-income) and 18% low density (high-income) localities. Thus, the 949 households sampled for the FSM household survey in the 50 socio-economic residential localities were distributed as follows:

High Density (low-income) residential areas: 37% of 949 = 351

Medium density (middle-income) residential areas: 46% of 949 = 437

Low Density (high-income) residential areas: 17% of 949 = 161

949

Balloting was then adopted to select the required number of localities per socio-economic group in each local government area. The same thing was done in the case of zones/areas/localities selected in each of the 12 Districts in Abuja Municipal Area Council and the 10 Districts in Yenagoa.

2.2.1. Household Survey Design

In each city the sampled households covered all the wards or districts in each of the local government area(s) of the municipality. This ensured a very good spread of the respondents over the geographical space and adequate representativeness. Results obtained from the survey accurately represent what is going on in the entire city of Abuja, Ibadan, and Yenagoa and not a section or a few areas of the cities. The maps of sampled household and FSM facilities in each of the three cities show this.

In all the three cities, only households that had toilet facilities were selected for the household fecal sludge survey. The selection of households with toilet facilities does not tilt the results towards the non-poor because most owners of pit toilets in Nigerian cities are the poor who cannot afford the expenses of constructing and maintaining water system toilets.

2.2.1.1 Abuja

(i) Survey Design

Abuja, Nigeria's Federal Capital Territory (FCT) is made up of six Area Councils (ACs) which are the equivalents of Local Government Areas (LGAs) in Ibadan and Yenagoa. The six Area Councils are: Abuja Municipal Area Council (AMAC), Abaji, Gwagwalada, Kuje, Kwali, and Bwari. Of the six ACs only AMAC has a municipal status and was the one selected in line with the selection of the five municipal local governments in Ibadan and Yenagoa. AMAC has the concentration of government Ministries, Agencies and parastatals, Foreign Missions and Embassies and organised private sectors. There are twelve (12) districts/wards in AMAC namely: City Centre, Garki, Gui, Gwagwa, Gwarinpa, Jiwa, Kabusa, Karshi, Karu, Nyanya, Orozo and Wuse (Table 4). The household and emptiers' surveys covered the entire twelve districts and held between 20 June and 05 July, 2011.

(ii) Household Survey

The 2010 projected population for Abuja Municipal Area Council (AMAC) using UNFPA's 9.2% growth rate was 1,152,613 or 226,333 households from which 844 (0.37%) was planned to be interviewed at an average of 70 households per district or ward. However, 801 households (0.35%) were interviewed because many of the households in Jiwa, Gui and Gwagwa did not have toilet facilities which is a major selection criteria for the survey (Figure 3, Table 3 and Table 4).

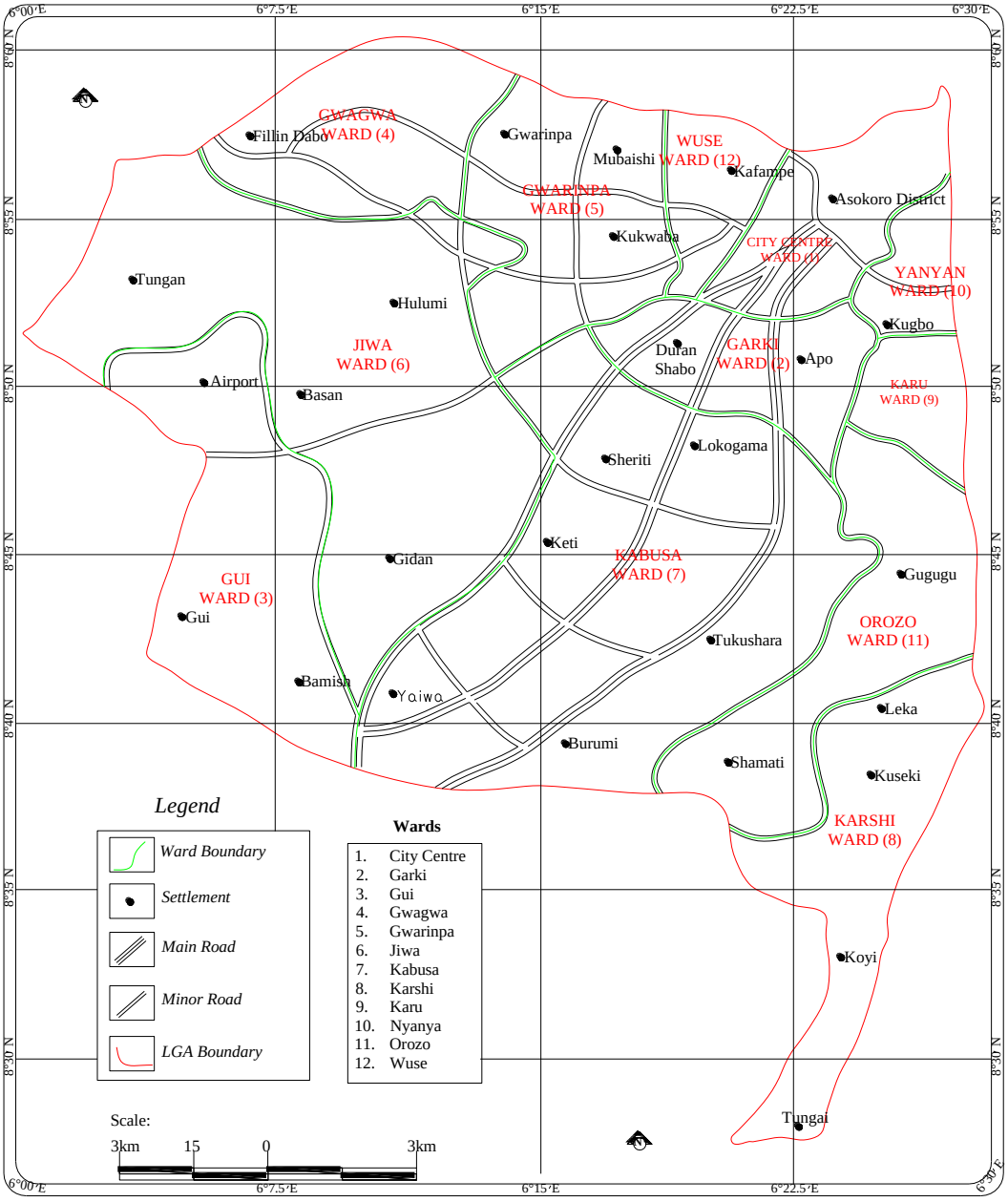
Table 3 Sample frame in Abuja Municipal Area Council

City	LGA	Wards / Communities / Districts	Population size	Selected Number of household	No of Households per Ward/District	Remarks
Abuja	*Abuja Municipal Area Council ***0.35% of***	12	1,152,613	844	70	5 other LGAs were not included as they are not

	AMAC H/hold population is included					under the Municipal Area: Bwari, Gwagwalada, Abaji, Kwali, Kuje

Figure 3 Political districts in the context of Abuja Municipal Area

Fig. 3.3: Political District in the Context of Abuja Municipal Area Council



Source: Abuja Area Municipal Council, 2010.

Council

Table 4 Distribution of Households Surveyed in Abuja Municipal Area Council

S/No.	District	Number of Households Interviewed
1.	City Centre	69
2.	Garki	70
3.	Gui	40
4.	Gwagwa	54
5.	Gwarinpa	76
6.	Jiwa	55
7.	Kabusa	77
8.	Karshi	70
9.	Karu	69
10.	Nyanya	70
11.	Orozo	65
12.	Wuse	86
	TOTAL	**801**

Community sensitization preceded household survey in Abuja. District Heads and their officials were visited and sensitized about the survey in each of the 12 districts. The community representatives were fully briefed about the purpose of the survey being sponsored by the Bill and Melinda Gates Foundation in three cities in Nigeria and four other countries in Africa; the anticipated output and outcome.

(iii) Selection of Respondents

The plan was for 844 households to be interviewed, however, a total of 801 households were interviewed in 12 districts/localities in AMAC at an average of seventy (70) households per district. The houses and households for sampling in each of the districts were purposively

selected based principally on availability of toilet facilities) within the houses in which they lived and to which the respondents had direct access. Based on this criteria, only about nine (75%) of the districts had sufficient households with direct access to toilet facilities. However, the selection of the 801 households that were eventually used for the survey in each district ensured spatial spread (Figure 4, Table 5).

In Abuja (as in Ibadan and Yenagoa) only one household was interviewed per house. In situations where there were more than one household in a house or compound, only one was picked for the interview. The household head (male or female) was the preferred target for the household interview. Where the head was not available another member of the household next to the head of household in social rank (e.g. wife, husband, eldest child not below 18 years of age) or a tenant resident in the house continuously in the last three (3) years was interviewed.

In a situation where the household in a house was not willing to participate in the interview, the house was skipped and the next one picked for the interview. Interview took place much more from 18.00 hours to 22.00 hours on week days because residents of the municipal area were largely office workers who usually returned home from work from 17.30hours. On Saturday and Sunday respondents were much more available. In some areas the time taken by the FAs was longer than the planned/ allocated time due to additional time spent to explain to or wait for respondents to fully attend to them. Some of the districts such as Gui, Gwagwa, and Jiwa were farther than the estimated distances and this made the time taken to commute from operational base of the FAs longer.

Appointed interviewers (Research Assistants and Field Assistants) were mostly Polytechnic and University graduates with such qualifications as N.C.E, HND, B.Sc, M.Sc, and MPH who had experience in socio-economic and environmental research, especially questionnaire administration. The interviewers were supplied with GPS equipment to geo-reference the location of every household surveyed and the fecal sludge facility.

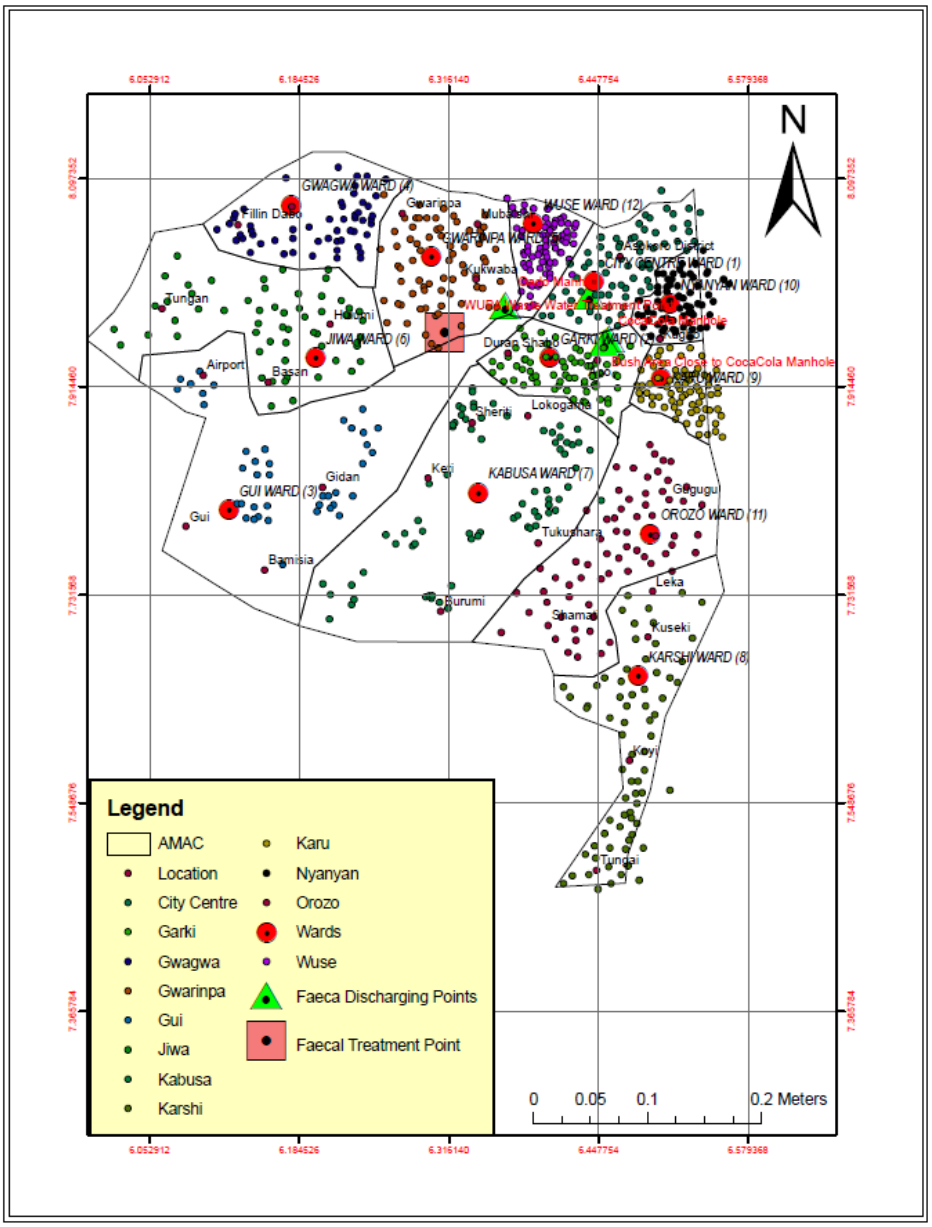


Figure 4 Sampled points in Abuja (AMAC) 2011

2.2.1.2 Ibadan

Ibadan is the largest indigenous city in tropical Africa. It has been a centre of administration of the Western Region, Western State, old Oyo and the present Oyo state. Its metropolitan area is made up of five local government areas while it has six rural local government areas. Agriculture and commerce is the major driver of its economy apart from government

institutions and a few industries that also offer employment to people. There are over 16 markets (Gege, Orita-merin, Oja-Oba, Oje, Oranyan etc.) in indigenous areas and over 21 in modern areas (New gbagi, Aleshinloye, Agbowo, Bodija, Eleyele, Ijokodo etc.) of Ibadan metropolis offering varieties of specialised and mixed goods. Bodija is a regional market patronised by people from different parts of Nigeria.

(i) Sample Frame and Sample Size

The sample frame for the study was determined using the National Population Commission's 2006 population figures projected from the 1991 census figures. The 2006 population census figures for the metropolitan areas of each city were then projected to 2010 using the UNFPA growth rates of 9.2% for Abuja, 3.46% for Ibadan and 2.9% for Yenagoa. The total number of households from the projected population of each city was calculated based on a mean family size of 6 per households and these represent the sample frame for each of the city. The last stage involved the determination of sample size for the household survey. Different percentages of the household total considered large enough for representation were adopted as sample size as shown in Table 5.

Table 5 Sample Frame and Sample Size for Ibadan

City	LGA	Wards / Communities / Districts	Population size	Selected Number of household	No of Households per Ward/District	Remarks
2)Ibadan Metropolis Population: **1,546,423** ***0.29% of 327,675***	*Ibadan North	12	354,490	190	16	
	*Ibadan North-West	11	176,594	189	17	
	*Ibadan South West	12	326,516	190	16	
	*Ibadan South East	12	307,406	190	16	

Households in Ibadan metropoli-tan LGAs is included	*Ibadan North East	12	381,417	190	16	
	Sub-total	59	1,546,423	949		
	6 other LGAs which are peripheral are not included: Akinyele, Lagelu, Egbeda, Ona-Ara, Oluyole, and Ido					

Sample Size

The 2010 projected population of the five municipal local government areas of Ibadan was 1,546,423 giving a household size of 327,675 out of which 0.29% or 949 households were selected as sample size. The breakdown of the samples per ward in the five LGAs is contained in Appendix 1.

(ii) Household Survey

Community sensitization preceded household survey. Community sensitization meetings took place in each of the five local government areas in Ibadan where Community Development Council (CDC) Chairmen and other community leaders (male and female) from each locality and the supervising Community Development Officers met at the respective Local Government Secretariat on different days. The community representatives were fully briefed about the purpose of the survey being sponsored by the Bill and Melinda Gates Foundation in three cities in Nigeria and four other countries in Africa, the anticipated output and outcome.

(iii) Selection of Respondents

A total of 949 households were interviewed in 52 localities in the five municipal LGAs in Ibadan at an average of 18 households per locality (Figure 5). The households for sampling in each of the cities were purposively selected based principally on availability of toilet facility(ies) within the houses in which they lived and to which the respondents had direct access. The sampled households were selected in each locality in a way that ensured spatial spread.

In Ibadan household survey was conducted from 21 May to 10 June, 2011, and only one household was interviewed per house. In situations where there were more than one household in a house or compound, only one was picked for survey. The household head (male

or female) was the preferred target for the household interview. Where the head was not available another member of the household next to the head of household in social rank (e.g. wife, husband, eldest child not below 18 years of age) or a tenant resident in the house continuously in the last three (3) years was interviewed.

Appointed interviewers (Research Assistants and Field Assistants) were mostly Polytechnic and University graduates with such qualifications as N.C.E, HND, B.Sc, and M.Sc who had experience in socio-economic and environmental research, especially questionnaire administration. The interviewers were equipped with GPS equipment to geo-reference the location of every household surveyed and the fecal sludge facility.

Interviews took place between 8am and 6pm Monday to Saturday and 2pm to 7pm on Sundays to allow Christian households and interviewers attend Sunday church service. Some of the respondents in the households were not available during the time originally scheduled between 8am and 5pm; as a result these were covered during late evenings or on another day as was the case in Abuja where most respondents who were civil servants returned from work from 5pm. There, interview took place from 5pm to 9pm and sometime 10pm. In some areas the time taken by the FAs was longer than the planned/ allocated time due to additional time spent to explain to or wait for respondents to fully attend to them. Some localities/zones in Ibadan and Abuja were farther than estimated distances.

In spite of the initial briefing with community representatives, some of the CDC members did not understand the mission of the project properly and as a result did not sensitize their neighbourhood members adequately which delayed data collection in some areas.

Figure 5 Sampled Households and FSM Facilities in Ibadan

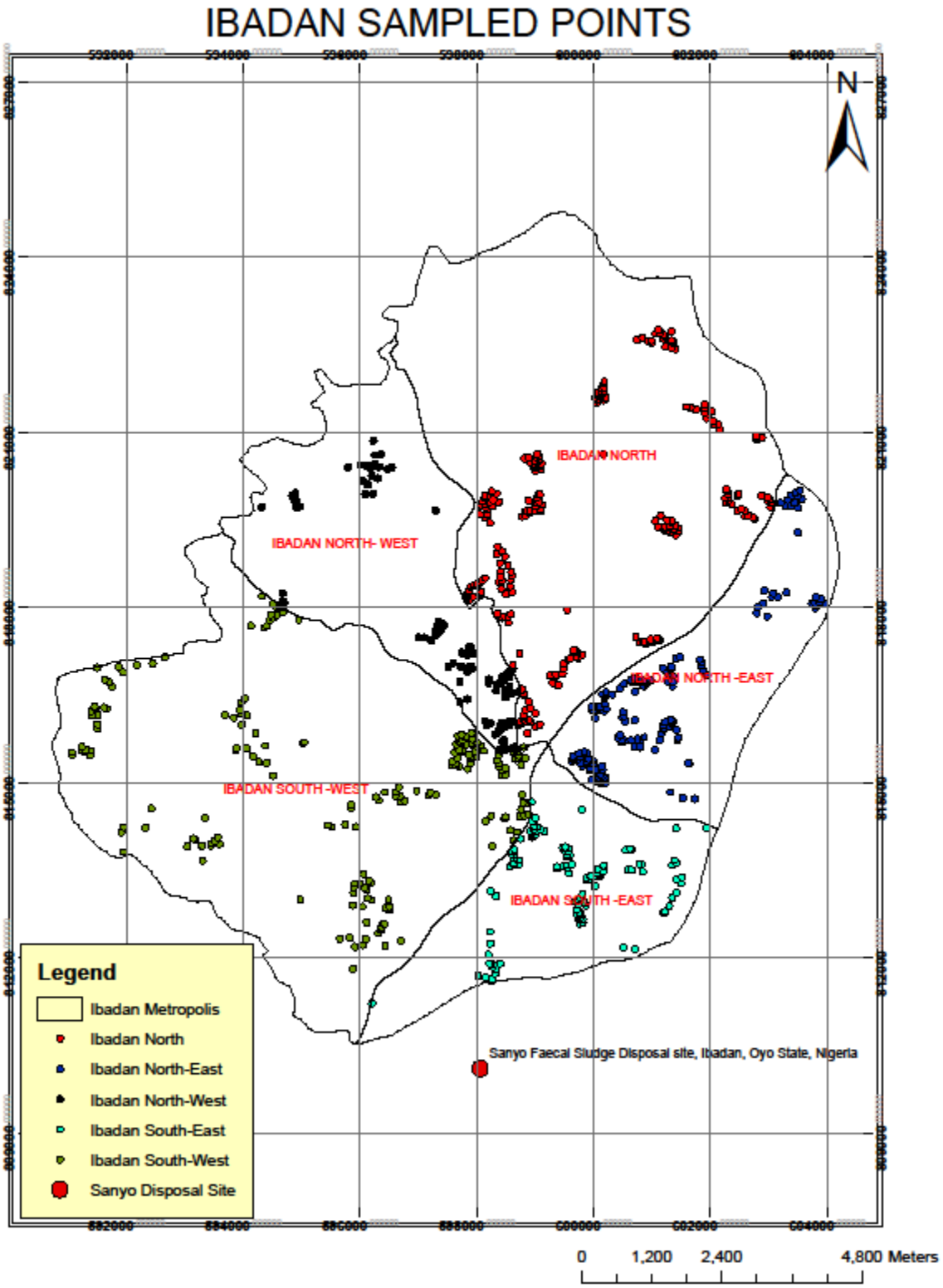


Figure 5 Sampling points in Ibadan

2.2.1.3 Yenagoa

(i) Survey Design

Yenagoa is the capital city of Bayelsa State in the Niger Delta. It is a municipal local government with only one political/administrative ward namely: Epi-Atisa. There are 16 communities out of which 10 were selected for interview. The 2010 projected municipal city population using 2.9% UNFPA growth rate was 399,963 giving a household size of 80,565 from which 0.3% sample size or 264 households were selected for survey. The sampled households were spread through ten districts namely: Azikoro, Biogbolo, Kpansia, Okaka Epie, Onopa, Ovom, Swali, Yenagoa, Yenizue-Epie, and Yenizue-Egene. The households and emptiers surveys held from 04 to 10 September, 2011.

(ii) Household Survey

A total of 264 households (0.3% of sample frame) were interviewed at an average of 26 households per district or locality. Community sensitization preceded household survey in Yenagoa (Tables 7 and 8). District Heads and their officials were visited and sensitized about the survey in each of the 10 districts and this was facilitated by the Field Assistants selected from the communities. The community representatives were fully briefed about the purpose of the survey being sponsored by the Bill and Melinda Gates Foundation in three cities in Nigeria and four other countries in Africa, the anticipated output and outcome.

Table 6 Sampling Frame in Yenagoa

City	LGA	Wards / Communities / Districts	Population size	Selected Number of household	No of Households per Ward/District	Remarks
3)Yenagoa **Population: 399,963**	Yenagoa	1 / 17	Total: 399,963	264	65	

0.3% of 80,565 Household population is included						
		1		261		
	Other LGAs were not within the Municipal Area and thus were not considered					

Table 7 Distribution of households surveyed in Yenagoa Municipal LGA

S/No.	District	Number of Households Interviewed
1.	Azikoro	16
2.	Biogbolo	12
3.	Kpansia	21
4.	Okaka Epie	27
5.	Onopa	48
6.	Ovom	66
7.	Swali	19
8.	Yenagoa	19
9.	Yenizue-Epie	21
10.	Yenizue-Egene	15
	TOTAL	**264**

(iii) Selection of Respondents

The 264 houses/ households for sampling in each of the ten districts were purposively selected based principally on availability of toilet facility(ies) within the houses in which they lived and to

which the respondents had direct access. The household samples were selected in each district in a way that ensured spatial spread (Figure 6).

Only one household was interviewed per house as was the case in Ibadan and Abuja. In situations where there were more than one household in a house or compound, only one was picked for the interview. The household head (male or female) was the preferred target for the household interview. Where the head was not available another member of the household next to the head of household in social rank (e.g. wife, husband, eldest child not below 18 years of age) or a tenant resident in the house continuously in the last three (3) years was interviewed.

In a situation where the household in a house was not willing to participate in the interview, the house was skipped and the next one picked for the interview. Interview took place much more from 08.00 hours to 18.00 hours each day but interviewers were largely disturbed by rains that fell daily in the communities. The FAs sometimes spent longer time with some respondents while trying to explain the objectives of the survey and the benefits to them.

Appointed interviewers (Research Assistants and Field Assistants) were mostly Polytechnic and University graduates with such qualifications as B.Sc, M.Sc, and MPH who had experience in socio-economic and environmental research, especially questionnaire administration. The interviewers were supplied with GPS equipment to geo-reference the location of every household surveyed and the fecal sludge facility.

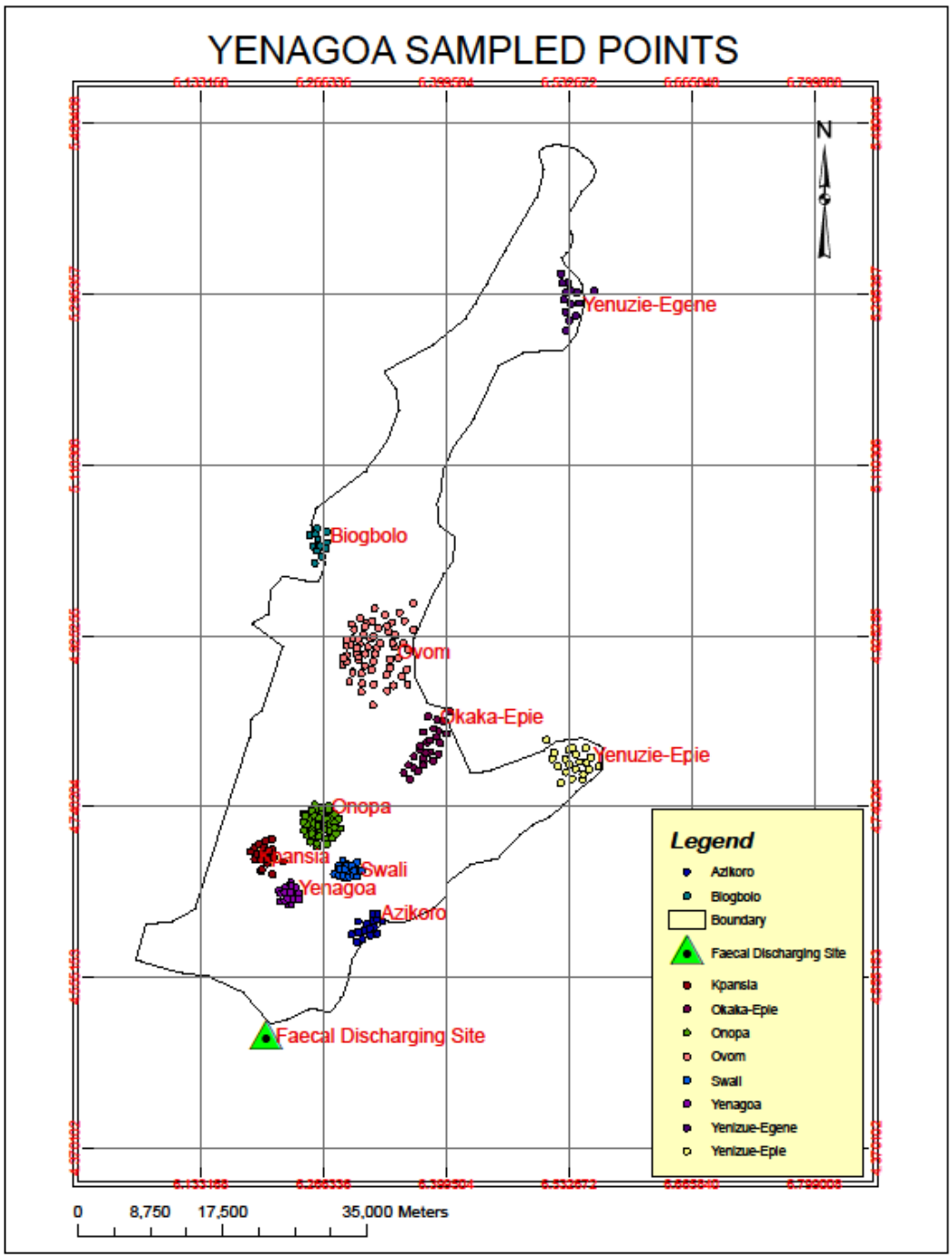


Figure 6 Sampling points in Yenagoa

2.2.2 FSM Practices and Data Collection

2.2.2.1 Abuja

Fecal Sludge Production

The survey was designed to find out the types of toilets in use and how sludge was being produced and the quantity produced by households in each of the twelve districts in Abuja (Table 5). The anticipated facilities include wastewater connection, pit latrine, VIP latrine, septic tank, aqua privy and any others. The dimensions of the pits or septic tanks were to be measured as a way of determining the capacity of the tanks and the volume of sludge they could hold. The survey was also to find out those who emptied the septic tanks/pits when filled and also collect their profiles.

Identification and Selection of FS Emptying Operators

The research team was to identify categories of persons or organizations involved in fecal sludge business in Abuja. The sources of this information were the households, FS stakeholders, the FS operators themselves, and the Abuja Environmental Protection Board. Five (5) mechanical emptiers were identified in Abuja and all the five were interviewed. In addition to the interview, their trucks were followed from the point of extraction to the point of discharge to capture the transportation aspects of the operations. For instance, TOSKO trucks were followed on typical routine evacuation trips by two Field Assistants. The routing included the evacuation activities at Gado Estate and Aso Clinic. The process included pumping of fecal sludge from septic tanks into trucks and the discharge of sludge into manholes.

2.2.2.2 Ibadan

Fecal sludge Production

The survey was designed to find out the types of toilets in use and how sludge was being produced and the quantity produced by households in each locality. The anticipated facilities

include wastewater connection, pit latrine, VIP latrine, septic tank, aqua privy and any others. The dimensions of the pits or septic tanks were to be measured as a way of determining the capacity of the tanks and the volume of sludge they could hold. The survey was also to find out those who emptied the septic tanks/pits when filled and also collect their profiles. However, the households were unable to estimate the quantity of fecal sludge produced in their households. Even where they were able to state the number of times the pits were emptied by emptiers, they could not give the quantity of sludge evacuated.

Identification and Selection of FS Emptying Operators

The research team was to identify categories of persons or organizations involved in fecal sludge business in Ibadan. The anticipated sources of this information are the households, FS stakeholders, the association of FS operators where they existed, and building artisans such as builders, and plumbers, and housing managers. The identified manual and mechanical operators were to be selected for interview on various aspects of their businesses.

In the case of manual operators, a maximum of 20 or the total number- whichever is less- were to be interviewed. In addition to interviewing all the mechanical operators (which number would likely be less than 20), their trucks were to be followed from the point of extraction to the point of discharge to capture the transportation aspects of the operations.

2.2.2.3 Yenagoa

Fecal Sludge Production

The survey was designed to find out the types of toilets in use and how sludge was being produced and the quantity produced by households in each of the twelve districts in Yenagoa. The anticipated facilities include wastewater connection, pit latrine, VIP latrine, septic tank, aqua privy and any others. The dimensions of the pits or septic tanks were to be measured as a way of determining the capacity of the tanks and the volume of sludge they could hold. The survey was also to find out those who emptied the septic tanks/pits when filled.

Identification and Selection of FS Emptying Operators

The research team was to identify categories of persons or organizations involved in fecal sludge business in Yenagoa. The sources of this information were the households, FS stakeholders, the FS operators themselves, and the Ministry of Environment. Information obtained indicated that there were both mechanical and manual emptiers in Yenagoa.

Five (5) mechanical emptiers were identified in Yenagoa and four were interviewed. There were also six manual emptiers mentioned by the respondents but only one of the emptiers was available for interview. In addition to the interview, one of the trucks was followed from the point of extraction to the point of discharge to capture the transportation aspects of the operations.

2.2.3 Methods to Validate Financial Data

The household data collected in the three cities were analyzed with SPSS and frequency tables and statistical illustrations (charts, graphs) were generated for critical analysis. The financial data was obtained primarily from the Emptier interviews. None had formal or audited financial reports on their respective emptying businesses. The interviewers had no control over what the emptier chose to divulge or withhold. That notwithstanding, validation entailed vetting the responses given by one emptier with the other and looking for similar trends across the data. Where the data seemed to be an outlier, the interviewers followed up with the Emptiers to get additional data.

2.2.4 Treatment Plant and Dump Site Models

2.2.4.1 Abuja

Sewage Disposal Site Visit

There are two types of FS disposal facilities in Abuja: one Central Waste Water Treatment Plant (WWTP) located in Wupa, and three (3) mini WWTPs serving the Barracks and Gudu district.

AEPB owned and maintained the facilities which handled mainly sewage and sullage. The project team visited the Waste Water Treatment Plant (WWTP) located in Wupa area of Abuja. The facility was assessed for potential beneficial end-use of the disposed sewage such as their potential for methane capture and utilization, composting business development. The site was also assessed on sewage treatment capacity and other pertinent sewage disposal site characteristics. Quantitative measured data (to the extent available) of the current sewage disposal site management processes, the history of the sewage disposal site and future projections of usage and lifecycle of the existing site were also collected. Additionally, the project team asked for data on current monetary revenues and methodologies from dumping activity and/or composting activity at the site. Photos and GPS coordinates of the disposal sites were taken during the site visits. These are presented in other sections of the report.

2.2.4.2 Ibadan

Sewage Disposal Site Visit

There is only one FSTP in Ibadan. It is owned by Oyo State Government under the control of the then Ministry of Environment and Water Resources (now Ministry of Environment and Habitat). The site, which is located in Sanyo area of the City, was opened in 2008 and it is operated as a no pay use facility. Septic tanks are evacuated and discharged at the dumpsite by registered contractors, while the non-registered contractors discharged at unapproved locations. A visit was paid to the site to ascertain its state of operation.

2.2.4.3 Yenagoa

Sewage Disposal Site Visit

Yenagoa has no dedicated fecal/septic sludge disposal facility. However, a major river flowing nearby is being used and a majority of toilets are built on the river thus allowing the feces drop into the water and carried away.

2.3 Determination of Financial Flows and Key Stakeholders

2.3.2 Key Stakeholders in FSM

Abuja

The key stakeholders in FSM in Abuja were to be identified and interviewed under Key Informant Interview using the appropriate question guide. The Abuja Environmental Protection Board (AEPB) was identified as a major stakeholder in FSM. The mission of the AEPB is to ensure the sustainability of the cleanliness of the environment of Abuja in regards to sanitation through monitoring of liquid waste and solid waste disposal and environmental monitoring.

AEPB is equipped with sewage (FS) tankers, dump trucks, pay loaders, RORO, and tippers for its operations. It undertakes FS emptying operations in the City. As part of the regulatory framework for FSM in Abuja, there is the AEPB, Act 1997. FS should not be discharged in manholes that are not flowing. There are over 10,000 manholes in the city (both district and trunk sewer manholes).

In terms of relationships with FS Emptiers operating in the city, the AEPB is empowered to register the mechanical emptiers and it had three of such on its register. These mechanical emptiers were on retainership.

For effective management of FS in Abuja, the central sewerage system in the city is based on the phases of development of the city's development plan. Phase I: Asokoro, Wuse I & II, CBD, Maitama, Garki is connected to the sewer and reticulated with sewer lines. Phase II: Jabi, Utako is reticulated with sewer lines. The remainder of phases II and III had not yet been reticulated with sewer lines as at the time of the survey. There is a major sewer line connecting Phases I, II and III.

As at the time of the survey, approximately 30% of the city was connected to the central sewerage system. The AEPB and private contractors handle the evacuation of fecal sludge of households that are not connected to the central sewer. The AEPB also handles the evacuation

of bleeding manholes and abatements are done within a 24-hour timeframe. In the event of AEPB being unable to handle evacuations or blockages, registered private contractors are engaged to handle the job. Emptiers can only operate within AMAC if they were registered otherwise they would be fined if caught. According to the AEPB, the informal emptiers (estimated to be 3 or 4) operate primarily at night and they primarily service estates and LGAs that are yet to be connected to the central sewer.

Ibadan

The key stakeholders in FSM in each of the cities were to be identified and interviewed under Key Informant Interview using the appropriate question guide. Such stakeholders in Ibadan include Ministry of Environment and Water Resources (now Ministry of Environment and Habitat), Environmental Health and Sanitation Units in the Local Government, Ministry of Health, Ministry of Physical Planning and Urban Development, Agencies, NGOs and CBOs. Interviews were held with the Director of Environmental Sanitation and Sewerage in the Ministry of Environment and Water Resources, the Heads of Environmental Health and Sanitation Units of the five municipal local government areas of Ibadan.

Yenagoa

The key stakeholders in FSM in Yenagoa is the Ministry of Environment. An interview was held by the team in the office of the Director in Charge of the Pollution Control. After the discussions, a visit was made to the dedicated FS disposal site which was a stream about 20km from Yenagoa city on the way to Okolobiri / Amassoma.

2.4 Market Size Calculation Method

The market size was determined for the local government areas / wards / councils that constitute the metropolitan areas of the selected cities (Table 9). The three selected cities included the capital city (Abuja), a secondary large city (Ibadan) and a mid-sized city (Yenagoa).

Table 8 City Councils / LGAs / Ward

S/N	Abuja	Ibadan	Yenagoa
1	Abaji	Ibadan North*	Epie-Attisa*
2	Abuja Municipal Council (AMAC)*	Ibadan North East*	Gbarain Ekpetiama
3	Bwari	Ibadan North West*	Okordia Zarama-Biseni
4	Gwagalada	Ibadan South East*	
5	Kuje	Ibadan South West*	
6	Kwali	Akinyele	
7		Lagelu	
8		Egbeda	
9		Ona-Ara	
10		Oluyole	
11		Ido	

** Local Government Areas / Wards / Councils selected for the study and used in calculating the market size*

The 2006 Census figures published by the National Population Commission were used as the baseline. The population figures for each of the cities from 2007 to 2016 was estimated using growth rates published by the UNFPA for FCT Abuja, Oyo State (Ibadan) and Bayelsa state (Yenagoa). The household size for 2010 was calculated based on the household survey results which included the number of persons living within each house and the number of households in each house (Tables 9 - 12).

Table 9 Abuja: Fecal Market Size

FCT Abuja				
Local Government Area	**2006 population[1]**	**2010 population[2]**	**2010 Household population[3]**	**Households with Toilet facilities[4]**
AMAC	776,298	1,152,613	226,333	181,509

Total	**776,298**	**1,152,613**	**226,333**	**181,509**

[1] *2006 Census Survey – National Population Commission*

[2] *projected +9.2% annual population growth rate from 2006 using UNFPA rates*

[3] *Average number of persons per household ~ 5 based on household survey results*

[4] *Households with improved sanitation (Pits / Water Closet) ~ 80.2% average from 2006 NPC statistics*

Table 10 Abuja: Annual Emptying Frequency of Households

Emptying frequency	Emptying Frequency Pits	# Pits Emptied/yr	Emptying Frequency Septic Tanks	# Septic tanks Emptied/yr
2 - 4 times/yr	6.7%	6,733	14.5%	25,415
Once/yr	17.7%	7,960	20.6%	16,184
Once/2 yrs	11.0%	2,470	19.2%	7,522
Once/3yrs	0.0%	0	1.5%	376
Once/4 yrs	1.2%	137	0.3%	57
5-10 yrs	1.2%	71	0.3%	30
Over 10 yrs	0.0%	0	0.0%	0
Not yet done	62.2%	0	43.6%	0
	TOTAL Pits emptied / year	**17,372**	**TOTAL Septic tanks emptied / year**	**49,584**

**Emptying frequency for pits and septic tanks based on Household survey data*

The total pits emptied / year in Table 10 for Abuja was calculated based on the emptying frequency given in the household survey results. The calculations were extrapolated to the projected total population (not just the survey population) in Abuja with pit latrines. Similarly, the total septic tanks emptied / year in Table 10 was calculated based on the emptying frequency given in the household survey results. The calculations were extrapolated to the projected total population (not just the survey population) in Abuja with septic tanks.

Table 11 Ibadan: Fecal Sludge Market Size

Ibadan				
Local Government Area	**2006 population[1]**	**2010 population[2]**	**2010 Household population[3]**	**Households with Toilet facilities[4]**
Ibadan North East	330,099	381,417	80,819	65,562
Ibadan North	306,795	354,490	75,114	67,631
Ibadan North West	152,834	176,594	37,419	31,277
Ibadan South East	266,046	307,406	65,137	53,067
Ibadan South West	282,585	326,516	69,186	56,906
Total	1,338,359	1,546,423	327,676	274,444

[1] *2006 Census Survey – National Population Commission*

[2] *projected +3.46% annual population growth rate from 2006 using UNFPA rates*

[3] *Average number of persons per household ~ 5 based on household survey results*

[4] *Households with improved sanitation (Pits / Water Closet) ~ 83.7% average from 2006 NPC statistics*

Table 12 Ibadan: Annual Emptying Frequency of Households

Emptying frequency	Emptying Frequency Pits	# Pits Emptied/yr	Emptying Frequency Septic Tanks	# Septic tanks Emptied/yr
2 - 4 times/yr	5.5%	15,832	3.4%	8,941
Once/yr	12.1%	17,355	9.2%	11,921
Once/2 yrs	41.4%	29,686	47.4%	30,697
Once/3yrs	6.6%	3,115	3.9%	1,672
Once/4 yrs	5.1%	1,827	1.8%	596
5-10 yrs	7.9%	1,464	8.3%	1,395
Over 10 yrs	1.3%	183	0.9%	119
Not yet done	20.2%	0	25.1%	0
	TOTAL Pits emptied / year	**69,461**	**TOTAL Septic tanks emptied / year**	**55,341**

**Emptying frequency for pits and septic tanks based on Household survey data*

The total pits emptied / year in Table 12 for Ibadan was calculated based on the emptying frequency given in the household survey results. The calculations were extrapolated to the projected total population (not just the survey population) in Ibadan with pit latrines. Similarly, the total septic tanks emptied / year in Table 12 was calculated based on the emptying frequency given in the household survey results. The calculations were extrapolated to the projected total population (not just the survey population) in Ibadan with septic tanks.

Table 13 Yenagoa: Fecal Sludge Market Size

Yenagoa				
Local Government Area	**2006 population[1]**	**2010 population[2]**	**2010 Household population[3]**	**Households with Toilet facilities[4]**
Yenagoa	353,344	399,963	80,565	28,957
Total	353,344	399,963	80,565	64,609

[1] *2006 Census Survey – National Population Commission*

[2] *projected +2.9% annual population growth rate from 2006 using UNFPA rates*

[3] *Average number of persons per household ~ 5 based on household survey results*

[4] *Households with improved sanitation (Pits / Water Closet) ~ 35.9% average from 2006 NPC statistics*

Table 14 Yenagoa: Annual Emptying Frequency of Households

Emptying frequency	Emptying Frequency Pits	# Pits Emptied/yr	Emptying Frequency Septic Tanks	# Septic tanks Emptied/yr
2 - 4 times/yr	7.1%	507	8.9%	5,092
Once/yr	42.9%	1,365	22.4%	5,763
Once/2 yrs	25.0%	398	21.1%	2,719
Once/3yrs	0.0%	0	2.5%	215
Once/4 yrs	0.0%	0	0.8%	54
5-10 yrs	0.0%	0	1.7%	57
Over 10 yrs	0.0%	0	0.0%	0

Not yet done	25.0%	0	42.6%	0
	TOTAL Pits emptied / year	**2,271**	**TOTAL Septic tanks emptied / year**	**13,900**

**Emptying frequency for pits and septic tanks based on Household survey data*

The total pits emptied / year in Table 14 for Yenagoa was calculated based on the emptying frequency given in the household survey results. The calculations were extrapolated to the projected total population (not just the survey population) in Yenagoa with pit latrines. Similarly, the total septic tanks emptied / year in Table 14 was calculated based on the emptying frequency given in the household survey results. The calculations were extrapolated to the projected total population (not just the survey population) in Yenagoa with septic tanks.

2.4.1 FS Production and Collection Computation

The survey was designed to find out the types of toilets in use and how sludge was being produced and the quantity produced by households in each locality in the three cities. The facilities included wastewater connection, pit latrine, VIP latrine, septic tank, comfort stations and any others. The dimensions of the pits or septic tanks were to be measured as a way of determining the capacity of the tanks and the volume of sludge they could hold. The survey was also to find out those who emptied the septic tanks/pits when filled and also collect their profiles.

Since majority of the surveyed households could not provide an estimate of the quantity of fecal sludge produced in their households, two different methods were used to derive the quantity of fecal sludge produced using the data points in the survey results. The two methods used are further explained in Section 3.2.

The volume of FS collected by mechanical operators was estimated based on the number of household trips made per year by each emptying Company in each city. The calculation also assumed full truck loads.

Annual Volume collected (m^3) = Annual Household trips x Truck capacity (m^3)

In the absence of quantitative data from informal operators, it was assumed that the informal mechanical operators handled the delta between the number of septic tanks that are emptied per year (Table 16 and the number of septic tanks emptied annually by the registered emptiers. The volume of FS 'collected' by manual operators was estimated based on the number of pits that needed to be emptied each year in each city. In Yenagoa, proxy figures where used based on observations during the survey period for one registered mechanical emptier that refused to be interviewed.

Table 15 Households Served by Emptier Type

Septic Tanks	% of Households serviced by Registered Emptiers*	Estimated % of Households serviced by Informal Emptiers
Abuja	23%	77%
Ibadan	4%	96%
Yenagoa	4%	96%

** Based on Emptier interview data*

The above results (Table 15) would seem to indicate that the households are served primarily by emptiers in the informal sector. However, the project team assumes otherwise based on the results of the household survey and the indications given on the number of informal operators. Especially in Ibadan where the Emptiers are few in number and in Yenagoa where the overall household population is small. We think the Emptiers in the absence of keeping trips logs were unable to provide reasonable estimates of the number of household trips taken in a given period.

2.5 Financial Analysis Methodology

Income statements were generated for each emptier in each city. None of the emptiers had

official published financial statements. Most of the data for the income statements was obtained during the interview process. Where actual financial data was not available from the interviewed entities, proxy data was used to create the Net Income statements. The Net income statement provided a good indication of whether the businesses were operating at a loss or profit. The Net income statement was analysed in two broad categories with the aim of maximizing current profits. The two levers manipulated to maximize profits were the revenue streams and the operating expenses. In the case of businesses operating at a loss, the aim was to determine the number of trips needed in order to minimize losses and breakeven.

A comparative analysis of the current service delivery models was done for the various service providers in each of the cities using the generated income statements. The results were examined thoroughly to identify areas of opportunity for growing service revenues (through pricing, service coverage area expansion etc.) and reducing operating expense (through self-help initiatives to drive down costs in the big spend buckets).

3.0 RESULTS AND ANALYSIS OF URBAN FSM PRACTICE

3.1 Situational Analysis of extraction/transportation

3.1.1. Demographic Characteristics of Respondents in the Three Cities

3.1.1.1 Socio-economic and Demographic Characteristics of Respondents in Abuja

The study area, AMAC LGA in Abuja with a sample size of 801 was divided into 10 wards/communities for the purpose of this study (Figure 7). The mean number of households in a house was 3.76 with a minimum of 1 and a maximum of 28 households. Also, the mean number of persons living in the house was 15.99±15.45 (Figure 7 and Table 16).

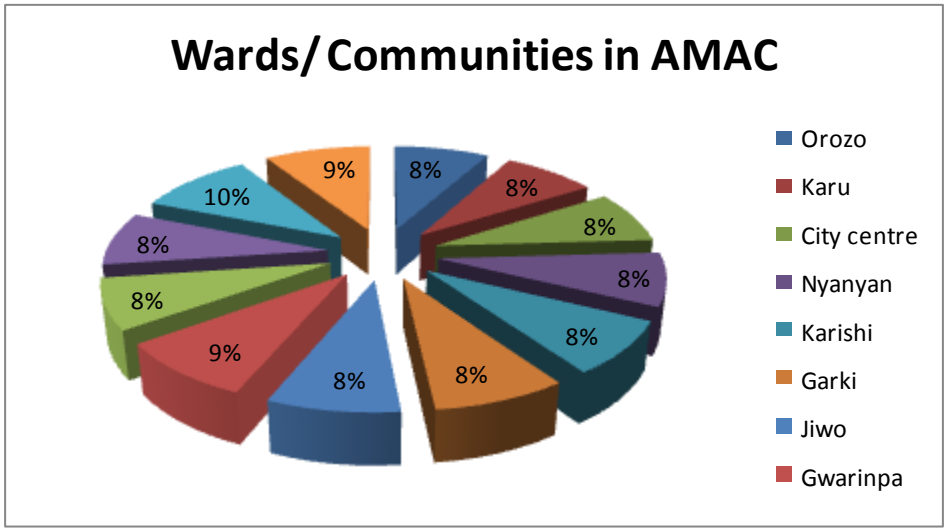


Figure 7 Wards/Communities in AMAC LGA, Abuja

Table 16 Mean Number Residents in houses in AMAC, Abuja City

	Number of Household in the house	Number of persons living in the house
Mean	3.76	15.99
Median	2.00	10.00
Std. Deviation	3.88	15.45
Minimum	1	1
Maximum	28	100

Table 17 shows the demographic characteristics of the respondents. Forty-eight percent of the respondents were household heads; about 52% were household members, while only one person claimed to be the caretaker. About 44% of the respondents also owned the houses where the interview took place, while about 54% were tenants. The others, which constitute 2%, were property manager, relation, security, or house maid.

Very few (4.0%) of the respondents had no formal education, while 30.6% and 55.2%% had secondary and tertiary education respectively. A sizeable proportion of the respondents (37.7%) were civil servants, 25.5 % were traders, 4.6% were farmers, while another 4.6% were engaged in teaching. The other respondents (21.2%) were engaged in activities such hair dressing, fashion designing, bricklaying, housemaid, and other private practice. However, only 6 (0.7%) of the respondents claimed to hold social positions in their various communities (Figure 8). The positions include: head of community as shown in Table 15 and Figure 9.

Table 17 Demographic Characteristics of Respondents in Abuja

Variables	Frequency	Percentage
Number of Households in the house		
1-5	630	78.6
6-10	129	16.1
11-15	24	2.8
16-20	11	1.3
21-25	4	0.6
26-30	*2*	0.2
Number of Persons living in the house		
< 10	396	49.4
10-19	170	21.1
20-29	104	12.8
30-39	62	7.7
40-49	36	4.4
50-59	14	1.6
60-69	6	0.7
70-79	5	0.6
80-89	5	0.5
90-100	3	0.3
Total	801	100.0

Status of Respondent		
Household Head	387	48.3
Household Member	413	51.6
Caretaker	1	0.1
Total	801	100.0
Status of the Respondents		
Owner	356	44.4
Tenant	429	53.6
Others	16	2.0
Total	801	100.0
Sex of Respondent		
Male	486	60.7
Female	315	39.3
Total	801	100.0
Level of Education		
Primary	53	6.6
Secondary	245	30.6
Tertiary	442	55.2
Quranic	6	0.7
Vocational	23	2.9
None	32	4.0
Total	801	100.0
Main Occupation of Respondent		
Civil Service	302	37.7
Trading	204	25.5
Farming	37	4.6
Teaching	37	4.6
None	51	6.4

Others	170	21.2
Total	801	100.0

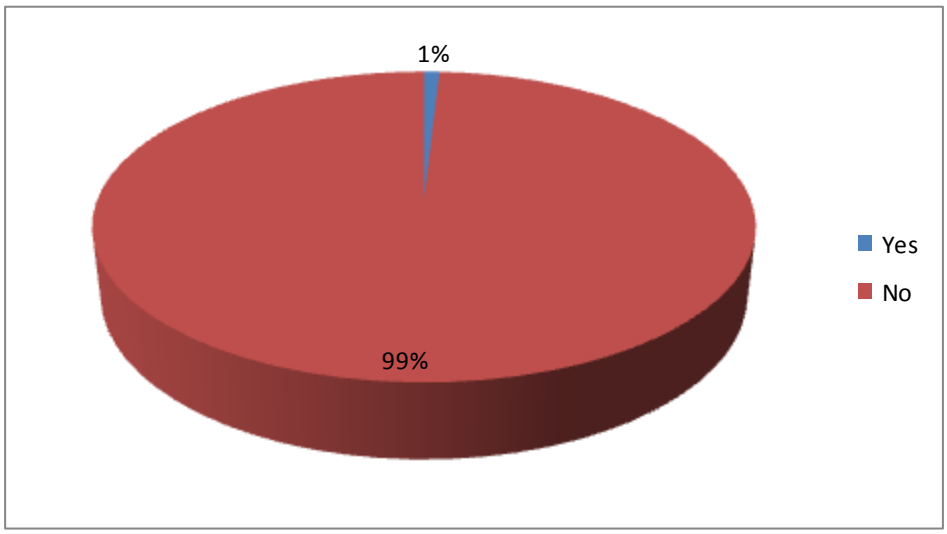


Figure 8 Percentage of Respondents holding Positions in the Community (Abuja)

Table 18 Abuja: Positions Respondents hold in the Community

Position	Frequency	%
Head of the Community	3	0.4%
Youth Leader	2	0.2%
Internal Auditor	1	0.1%
None	795	99.3%
Total	801	100.0%

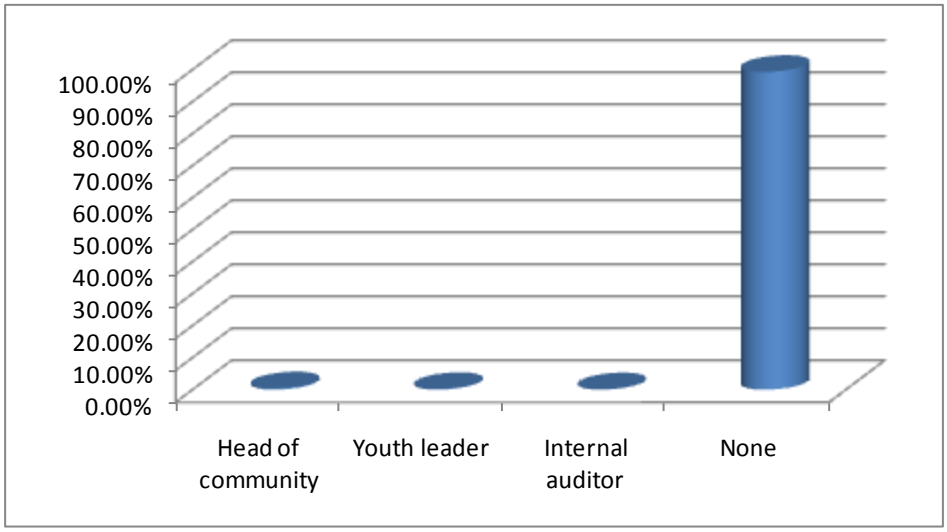


Figure 9 Abuja: Positions held by respondents in their communities

Of all the respondents interviewed, 54.1% possessed cars, 10.2% and 1.1% possessed motorcycle and bicycle respectively, while 34.6% had no personal means of transportation (Figure 10). A very high percentage (61.2%) used kerosene for cooking, while 29.2%, 6.0% and 3.6% used gas, firewood, and charcoal respectively (Figure 11).

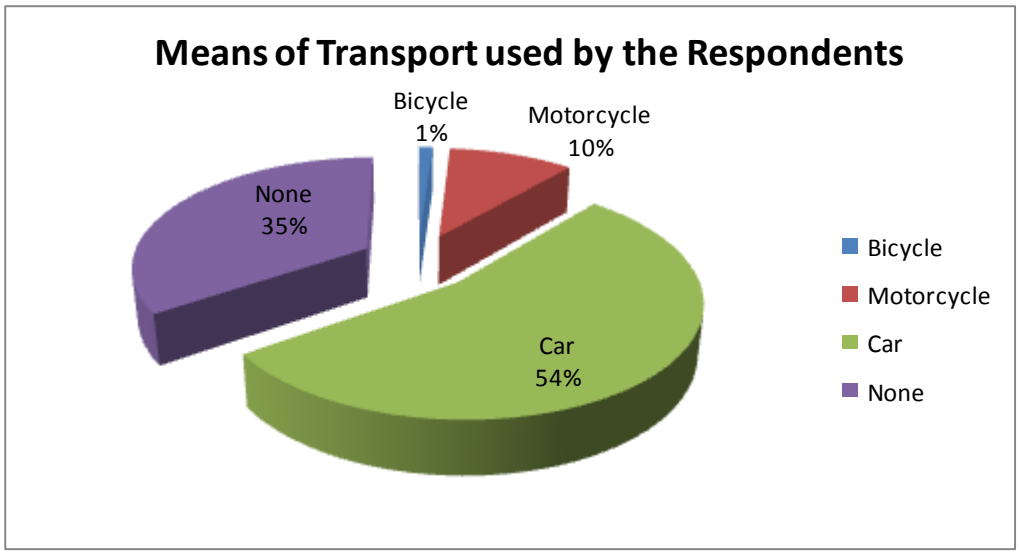


Figure 10 Means of Transportation Possessed by the Respondents (Abuja)

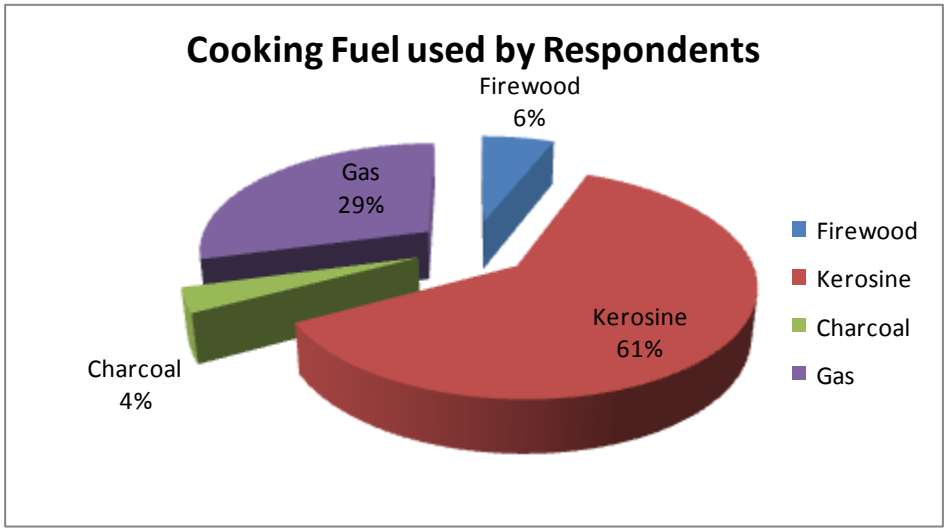


Figure 11 Abuja: Means of transportation used by Respondents

3.1.1.2 Socio-economic and Demographic Characteristics of Respondents in Ibadan

Ibadan city is divided into 5 LGAs as shown in Figure 12. The sample size of 949 was divided amongst the LGAs in the percentages shown in the Figure 12.

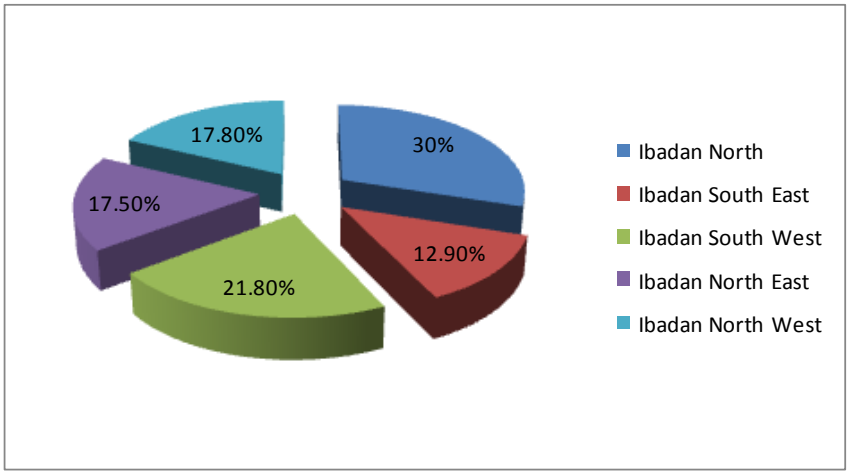


Figure 12 Sampled LGAs in Ibadan

In Ibadan city, the mean number of households in the houses was 4.66±3.71 with a minimum of one and a maximum of 30 households. Also, the mean number of persons living in the house was 17.94±13.3 with a minimum of one and a maximum of 120 persons (Table 19 and 20).

Majority (71.5%) of the respondents were household heads and 77.5% also owned the houses where the interviews took place; 32.6% and 21.7% of the respondents had secondary and tertiary education respectively, while 18.4% had no formal education. Major occupation of the respondents was trading (46.1%); only 6.1% were in the civil service. Only 21.3% of the respondents held important positions in their communities (Figure 13).

Table 19 Demographic Characteristics of Respondents in Ibadan

Mean Number of Households in the house		
Mean	4.66±3.72	
Minimum	1	
Maximum	30	
Mean Number of Persons living in the house		
Mean	17.9±13.3	
Minimum	1	
Maximum	120	

Table 20 Demographic Characteristics of Respondents in Ibadan

Variables	**Frequency**	**Percentage**
Number of Households in the house		
1-5	648	69.9%
6-10	220	23.7%
11-15	42	4.6%
16-20	12	1.2%
21-25	3	0.3%
25-30	2	0.2%
Number of Persons living in the house		

< 10	317	34.2
10-19	263	28.4
20-29	202	21.8
30-39	74	8.0
40-49	41	4.4
50-59	13	1.4
60-69	8	0.9
70-79	4	0.4
80-89	1	0.1
90-99	1	0.1
> 100	3	0.3
Total	927	100.0
Status of Respondent		
Household Head	663	71.5%
Household Member	264	28.5%
Total	**927**	**100.0%**
Owner	718	77.5%
Tenant	209	22.5%
Total	**927**	**100.0%**
Sex of Respondent		
Male	609	65.7%
Female	318	34.3%
Total	**927**	**100.0%**
Level of Education		
Primary	198	21.4%

Secondary	302	32.6%
Tertiary	201	21.7%
Quranic	35	3.8%
Vocational	20	2.2%
None	171	18.4%
Total	**927**	**100.0**
Main Occupation of Respondent		
Civil Service	57	6.1%
Trading	427	46.1
Farming	3.1	3.1%
Teaching	4.1	4.1%
None	14.1	14.1%
Others	26.4	26.4%
Total	**927**	**100.0%**

Others: Plumbing, Carpentering, Prophetess, Alfa, Architecture, Blacksmith, Baker, Tailoring, Grinding, Pensioner, Compressor repairer, Traditional medicine/herbalist, Hunter/Night guard, Electrician, Driving and Contractor.

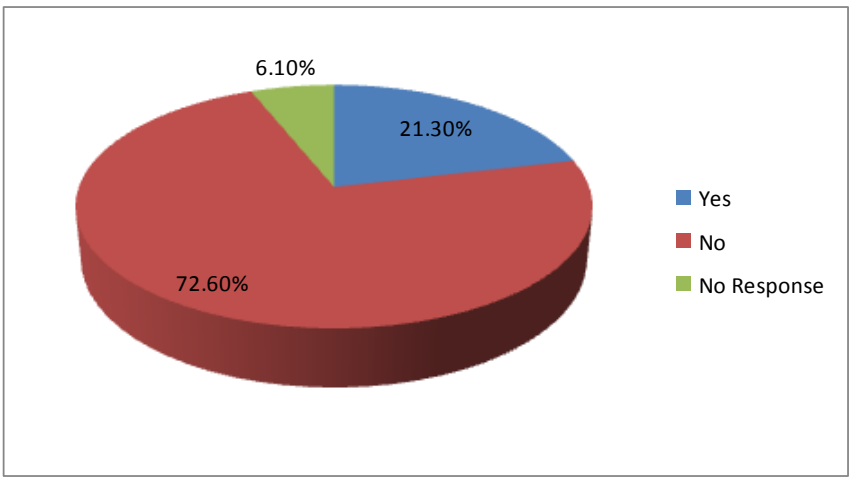


Figure 13 Ibadan: Percentage of respondents holding positions in the community

Table 21 shows the different positions held by the respondents. These varied from Baale, to executive members of Community Development Association (CDA) such as chairmen, vice chairmen, treasurer, etc; women leader, youth coordinator etc.

Table 21 Ibadan: Positions respondents hold in the community

Position	Frequency	%
Secretary of the CDA	24	12.2
Chairman of CDA	87	44.2
Welfare Officer of CDA	14	7.1
Chief Imam	10	5.1
Financial Secretary	5	2.5
Youth Coordinator	4	2.0
Women Leader	10	5.1
Baale	9	4.6
Mogaji	11	5.6
Assistant Secretary	2	1.0
Treasurer/Auditor of CDA	16	8.1
Vice Chairman of CDA	5	2.5
Total	197	100

Figure 14 shows the means of transportation enjoyed by participants; only 29.9% possessed a car, motorcycle and bicycle. A very high percentage did not have personal means of transportation. Also, majority (84.6%) of the respondents use kerosene as cooking fuel (Figure 15).

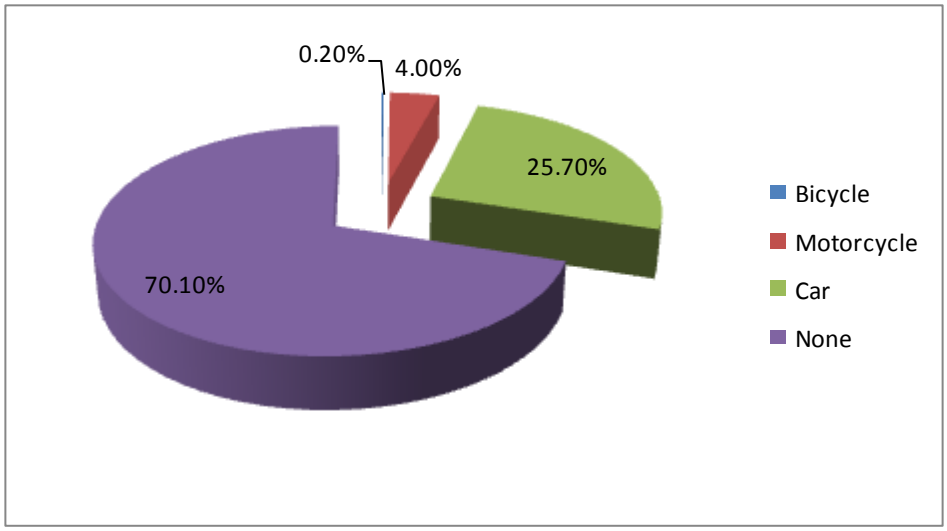


Figure 14 Ibadan: Means of transportation used by respondents

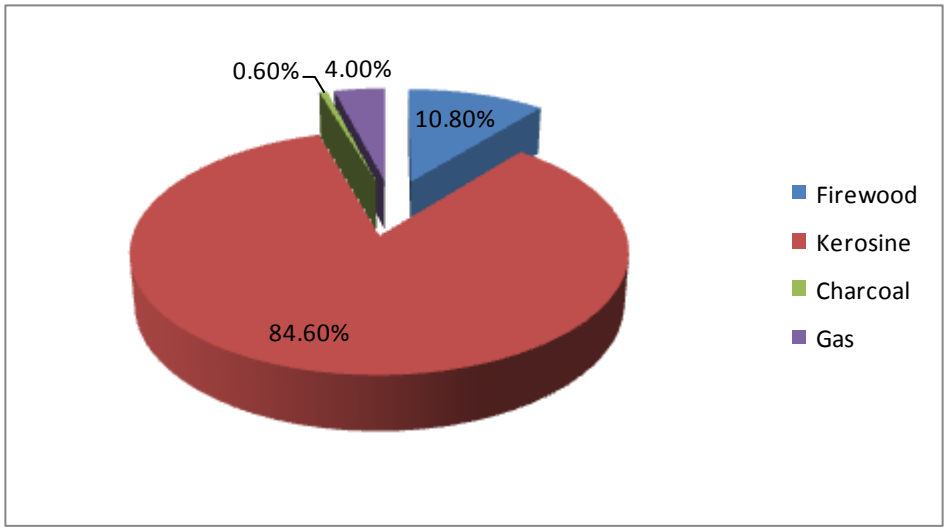


Figure 15 Ibadan: Cooking fuel used by respondents

3.1.1.3 Socio-economic and Demographic Characteristics of Respondents in Yenagoa

Yenagoa city is in Yenagoa LGA and 10 communities were surveyed as shown in Figure 16. The sample size of 264 was divided among the communities in the percentages shown.

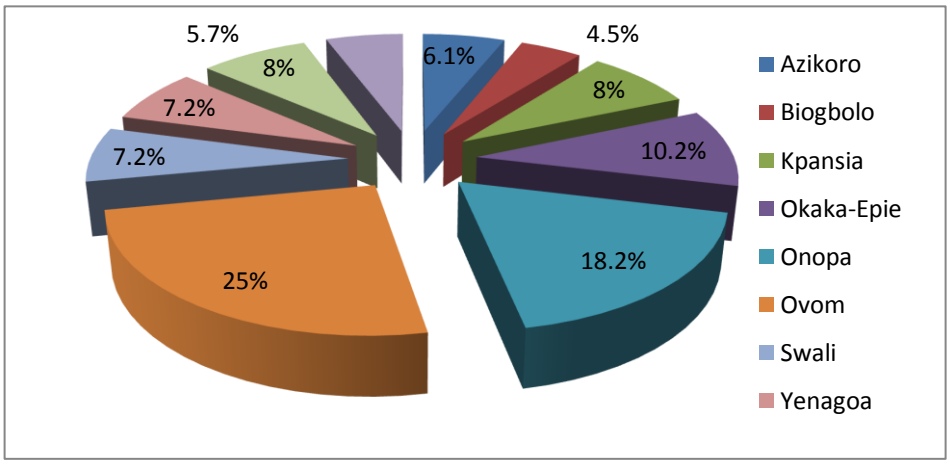


Figure 16 Yenagoa Communities

In Yenagoa city, the mean number of households in the houses was 3.71±3.44 with a minimum of one and a maximum of 24 households. The mean number of persons living in the house was 13.1±9.2 with a minimum of two and a maximum of 60 persons (Table 22).

Table 23 shows the demographic characteristics of the respondents. Majority (67.8%) of the respondents was household heads and 63.6% also owned the houses where the interview took place; 45.1% and 33.3% of the respondents had secondary and tertiary education respectively, while 10.6% had no formal education. Major occupation of the respondents was trading (36.0%) and 27.7% were in the civil service. Only 10.6% of the respondents held important positions in their communities (Figure 17).

Table 22 Mean Number Residents in houses in Yenagoa

	Number of Household in the house	**Number of persons living in the house**
Mean	3.71±3.44	13.1±9.2
Minimum	1	2
Maximum	24	60

Table 23 Demographic Characteristics of Respondents in Yenagoa

Variables	Frequency	Percentage
Number of Households in the house		
1-5	210	79.5%
6-10	41	15.5%
11-15	12	4.5%
>20	1	0.4%
Number of Persons living in the house		
< 10	138	52.3
10-19	74	28.0
20-29	34	12.9
30-39	12	4.5
40-49	3	1.1
50-59	2	0.8
60-69	1	0.4
Total	264	100.0
Status of Respondent		
Household Head	179	67.8%
Household Member	85	32.2%
Total	264	100.0%
Owner		
Tenant	168	63.6%
Others	87	33.0%
Total	9	3.4
Others: Daughter of the owner, Son of the owner, Relative of the owner	264	100.0%
Sex of Respondent		
Male	159	60.2%

Female	105	39.8%
Total	264	100.0%
Level of Education		
Primary	28	10.6%
Secondary	119	45.1%
Tertiary	88	33.3%
Vocational	1	0.4%
None	28	10.6%
Total	264	100.0
Main Occupation of Respondent		
Civil Service	73	27.7%
Trading	95	36.0%
Farming	17	6.4%
Teaching	6	2.3%
None	36	13.6%
Others	37	14.0%
Total	264	100.0%

Others: Surveyor, Student, Hair stylist, Fashion designer, clergy, Bricklayer, Plumbing, Retired

Table 24 shows the different positions held by the respondents. These varied from Chiefs, to executive members of Community Development Association (CDA) such as chairmen, vice chairmen, Secretary, financial secretary, etc.

Table 24 Yenagoa: Positions Respondents hold in the Community

Position	Frequency	%
Chief	11	39.6
Deputy Chief	3	10.7
CDC Chairman	6	21.4

Assistant Secretary	3	10.7
Financial Secretary	3	10.7
Deputy CDC Chairman	1	3.6
Secretary	1	3.6
Total	28	100

Figure 17 shows the means of transportation enjoyed by participants. Only 25.3% possessed cars. A very high percentage (70.9%) did not have personal means of transportation. For energy needs, majority (86.4%) of the respondents use kerosene as cooking fuel (Figure 18).

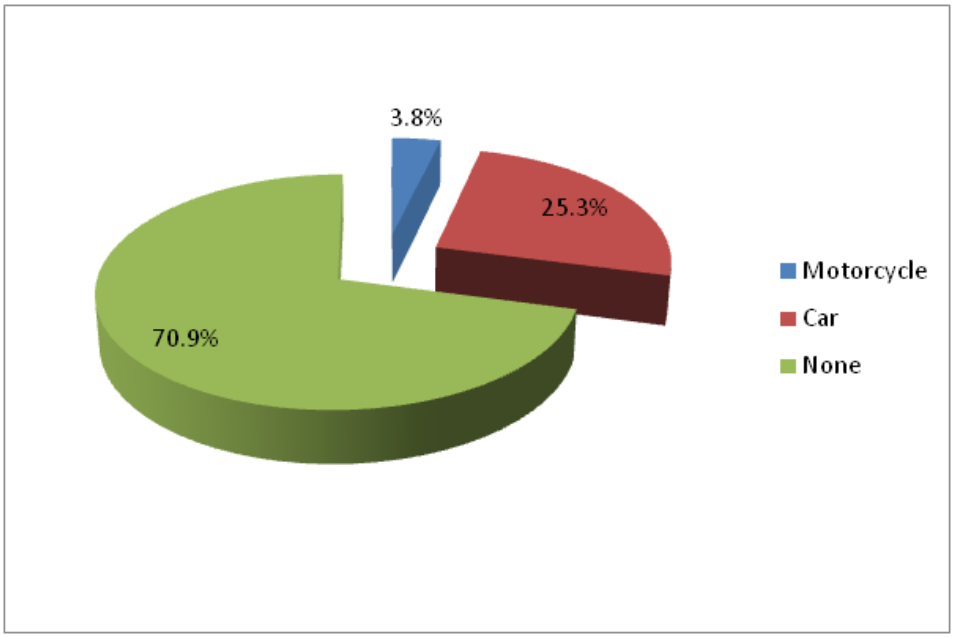


Figure 17 Yenagoa: Means of transportation used by respondents

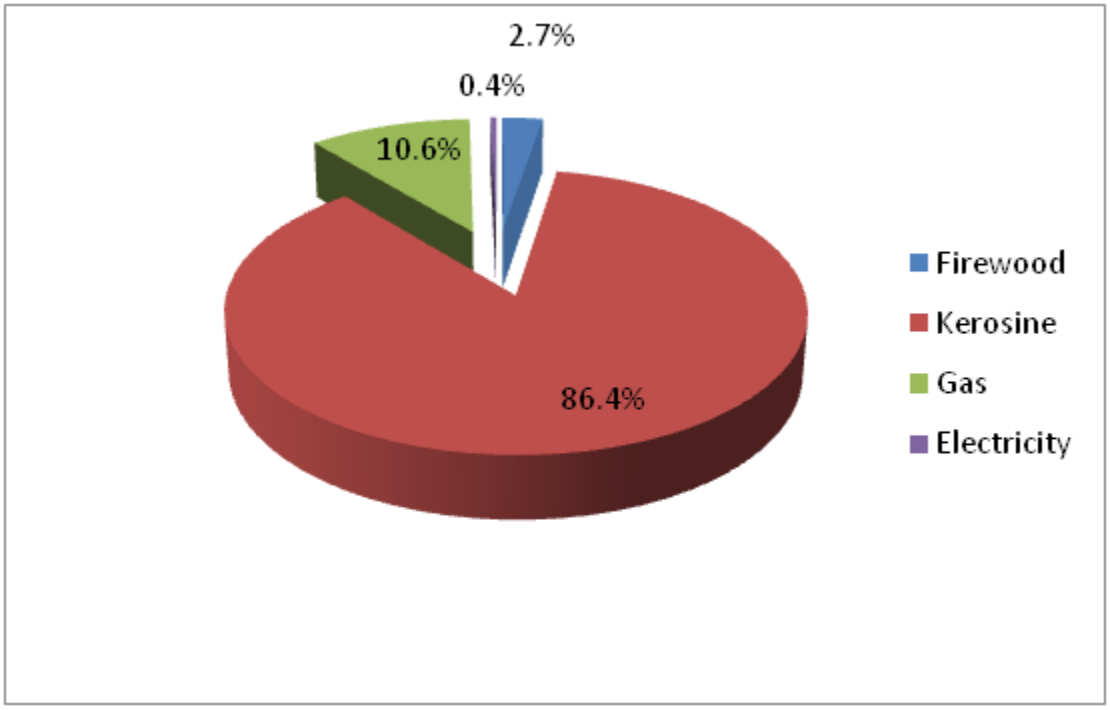


Figure 18 Yenagoa: Cooking fuel used by respondents

Variance in Home Ownership across the cities

The level of home ownership varies across the cities. 77.5% of respondents in Ibadan, 67.0% in Yenagoa and 44.4% in Abuja owned the houses in which they lived while 22.5% of respondents in Ibadan, 53.6% in Abuja and 33.6% in Yenagoa were tenants. There are more tenants in Abuja because majority of the population of AMAC are Federal and State civil servants who come from other parts of the country. Whereas the bulk of the residents of Ibadan municipality and Yenagoa city are indigenous population whose lineage have lived in the city for several years past and built the houses in which they live.

Inferential statistics using chi square (χ^2) at 5% level of significance showed that in Abuja, being a household head/member, level of education and occupation were statistically associated with home ownership ((p<0,05)). In Ibadan, In addition to these factors, holding a position in the community was also a very important factor (p<0.05). However, only two factors: being a

household head/member and holding a position in the community were statistically significant ($p<0.05$).

3.1.2. Drinking water supply coverage

3.1.2.1 Drinking water supply coverage in Abuja

Figure 19 shows the water supply coverage in AMAC, Abuja city. About thirty-four per cent (34.4%) of the respondents used pipe-borne water from the public water supply. However, 27.5%, 15.4%, and 22.7% relied on boreholes, wells and water vendors respectively.

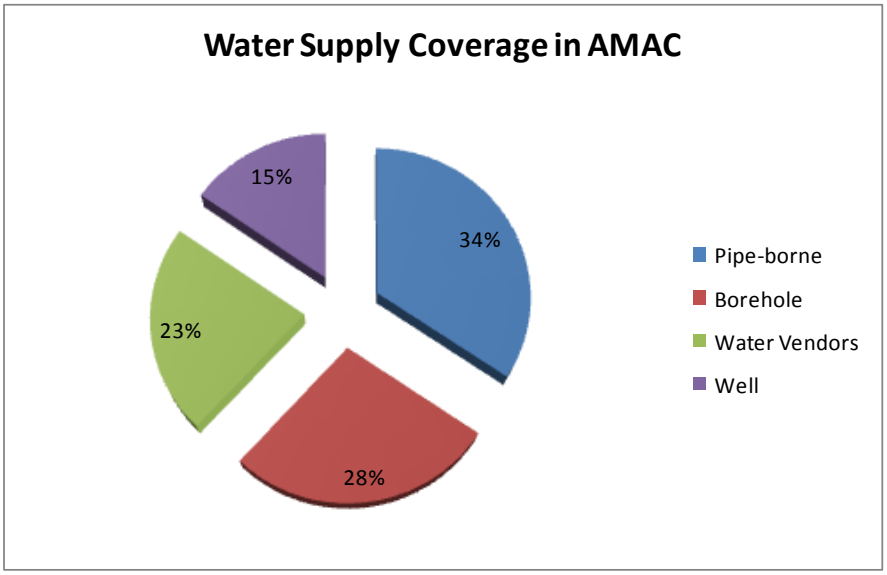


Figure 19 Water Supply Coverage in Abuja

The amount paid for water supply vary considerably. About half of the resppondents did not respond to the question on how much they paid. This may be due to the fact that some of them did not pay because they use their private wells, or the people using water vendors have never bothered to calculate how much they spent on water. However, the value paid ranged from USD 1.33 to 266.67 per month with a mean of USD30.75. Tables 25 -26 give the variation in the amount spent on water per month in US Dollars.

Table 25 Abuja: Statistics of amount paid for water per month

		Amount paid for water per month in USD
N	Valid	399
	No response	402
Mean		30.75
Median		26.67
Mode		26.67
Std. Deviation		29.93
Minimum		1.33
Maximum		266.67

Table 26 Abuja: Amount paid for water per month in USD (Grouping)

Amount in USD	Frequency	Percent
< 6.67	24	3.0
6.67-13.32	23	2.9
13.33-19.99	68	8.5
20-26.66	76	9.5
26.67-33.32	82	10.2
33.33-39.99	44	5.5
> 40	82	10.2
No Response	402	50.2
Total	801	100.0

3.1.2.2 Drinking water supply coverage in Ibadan

Majority of the respondents (67.5%) obtain their drinking water from wells, other sources of drinking water include pipe borne water (15.6%), borehole (14.5%). However, very few respondents claimed they got their water from spring (0.6%) and water vendors (0.6%) (Figure20), Amount paid for water varied considerably as seen in the table 27

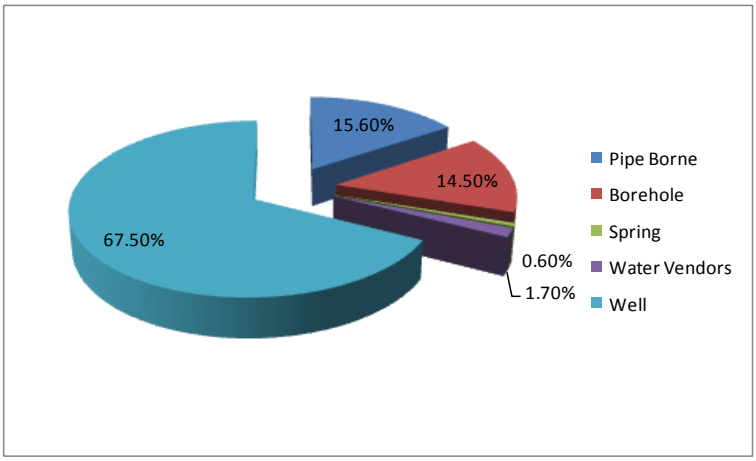


Figure 20 Sources of water used by respondents in Ibadan

Table 27 Amount paid for water supply per month in Ibadan (Grouping)

		Frequency	Percent
Valid	< 6.67	127	13.7
	6.67-13.32	43	4.6
	13.33-19.99	32	3.5
	20-26.66	22	2.4
	26.67-33.32	10	1.1
	33.33-39.99	7	0.8
	> 40	10	1.1
	No Response	676	73.9
Total		927	100.0

3.1.2.3 Drinking water supply coverage in Yenagoa

Figure 21 shows that majority of the respondents (61.4%) obtain their drinking water from borehole, other sources of drinking water include pipe borne water (8.7%) and water vendor (29.9%). Pipe borne water is also from borehole supply.

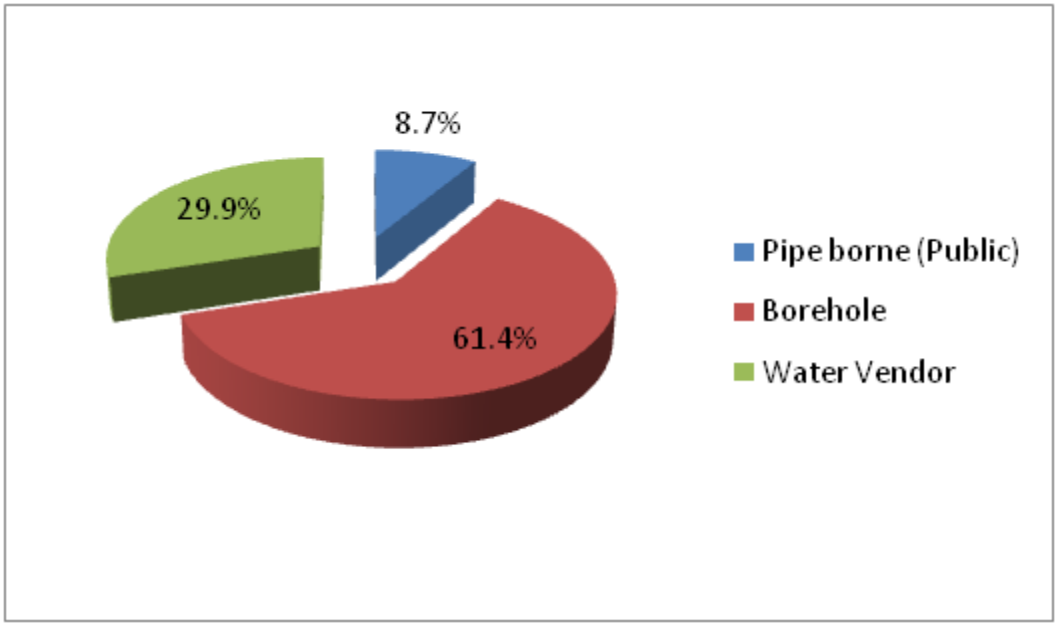


Figure 21 Sources of water used by respondents in Yenagoa

Amount paid for water supply per month.

The amount paid for water supply in Yenagoa ranged from USD3.33 toUSD120 per month with a mean of USD27.3 as shown in Table 28. The different ranges are shown in Table 26.

Table 28 Statistics of amount paid for water per month in Yenagoa

	Amount paid for water per month in USD
N Valid	194

	No Response	70
Mean		27.2921
Median		20.6667
Mode		20.00
Std. Deviation		16.84179
Minimum		3.33
Maximum		120.00

Table 29 Amount paid for water in Yenagoa per month in USD (Grouping)

		Frequency	Percent
Valid	< 6.67	7	2.7
	6.67-13.32	21	8.0
	13.33-19.99	25	9.5
	20-26.66	60	22.7
	26.67-33.32	22	8.3
	33.33-39.99	11	4.2
	> 40	48	18.2
	No Response	70	26.5
Total		264	100.0

3.1.3 Sanitation coverage in the three cities

3.1.3.1 Definition of terms for Sanitation Technologies in Nigeria

Pit latrine: Consists of a substructure (which is usually a hole in the ground in which the faeces is deposited and a cover slab which could be made of concrete slab or any locally available

material such as wood) and a supersructure (brick, block, wood wall with a roof made of available and affordable material)

VIP latrine: An upgraded/improved pit latrine with vent pipe and flyscreen to control fly breeding and odour.

Comfort Station: Aqua privy system for excreta disposal (essentially a septic tank located directly underneath a squatting plate. It has a 100-150mm diameter vertical drop-pipe extending some 100mm below the liquid level in the tank, thus forming a crude water seal), bath/shower rooms (ranged from 6 to 16), and a wash room for washing clothes. There were water taps, overhead tanks, and electricity supply. They were all functioning at start. Used water was to be recycled for flushing the toilets.

Septic Tank: Rectangular chambers cited below ground level, that receives both excreta and flush water from the toilets.

3.1.3.2 Sanitation coverage in Abuja

Only households with toilet facilities were considered for this study. Figure 22 presents the sanitation coverage in AMAC. 29.6% and 70.4% had off-site (connected to the sewer) and on-site facilities respectively.

Table 30 and Figures 23 and 24 show the breakdown of available sanitation technologies in Abuja Municipal Area Council (AMAC). Only 29.6% of the households interviewed were connected to the central sewer. This is in line with the information obtained from Abuja Emnvironmental Protection Board (AEPB) that only 30% of the city is connected to the central sewer. Nevertheless, Majority (43.2%) of the respondents use individual septic tanks while 24.8% use latrines (traditional and VIP).

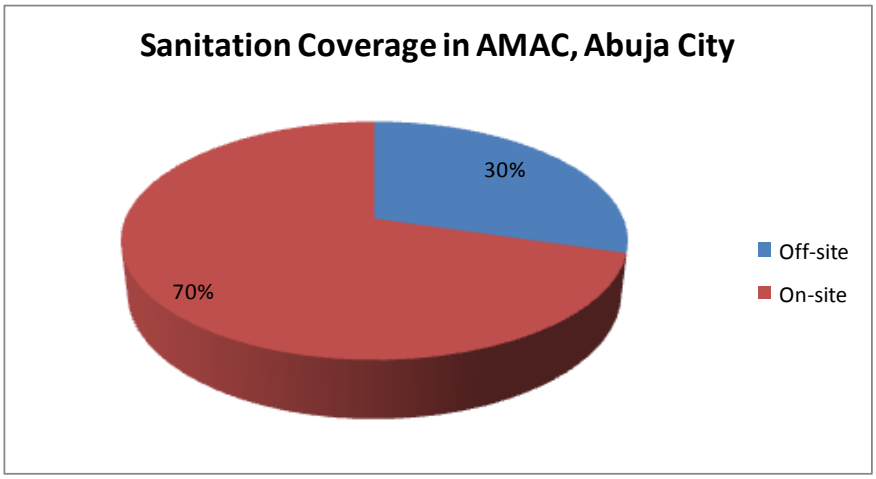


Figure 22 Sanitation Coverage in Abuja

Table 30 Site Sanitation Coverage in Abuja

Location		Frequency	Percentage
Off-Site (Sewer)	Sewer Connection	237	29.6
On-Site	Pit latrine	130	16.2
	VIP Latrine	69	8.6
	Comfort Stations	19	2.4
	Septic Tank	346	43.2
	Total	801	100.0

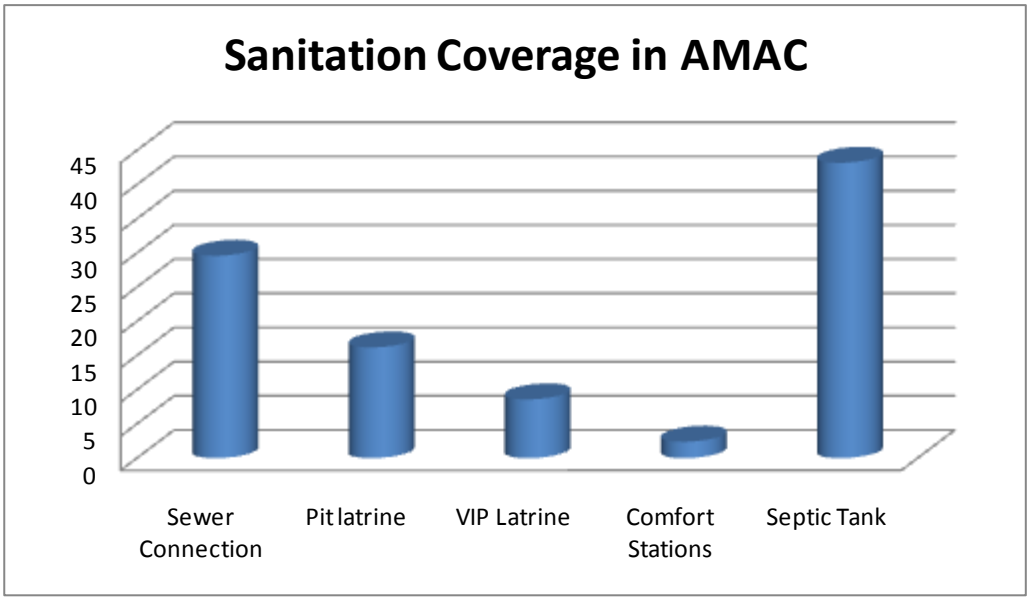


Figure 23 Breakdown of available sanitation technologies in Abuja

3.1.3.2 Sanitation coverage in Ibadan

Sanitation facilities used by the respondents include (Table 31) pit latrine (51.6%), and septic tank (47.10%). However, as shown in Figure 24, very small proportion of the respondents use VIP latrine (0.5%) while the rest connected the sewer for discharge of their sewage into the stream.

Table 31 Sanitation facilities in Ibadan communities

Pit latrine	51.6%	478
VIP latrine	0.5	5
Septic Tank	47.1%	437
Direct connection from WC to stream	0.6%	7

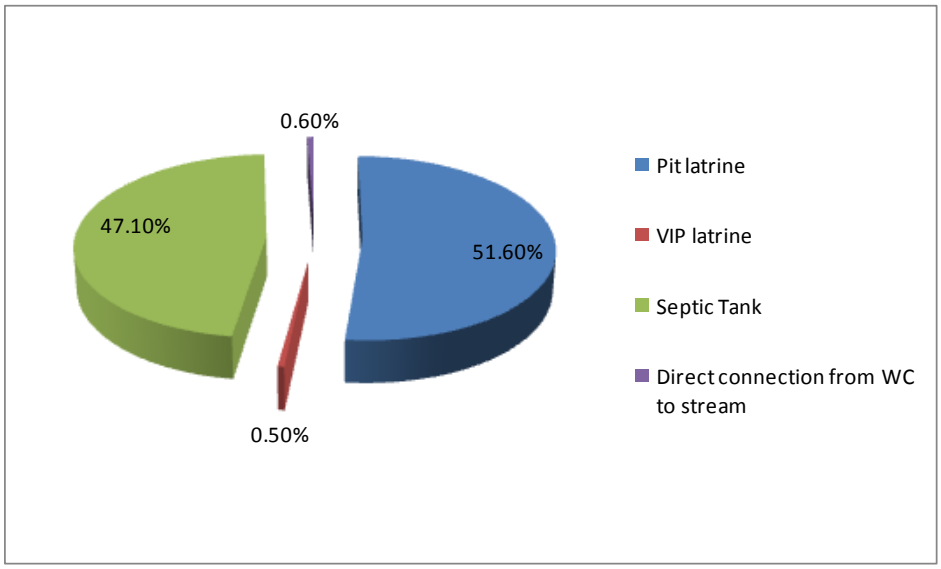


Figure 24 Ibadan: Sanitation facilities used by respondents

3.1.3.3 Sanitation coverage in Yenagoa

Sanitation facilities used by the respondents include septic tank (89.4%), VIP latrine (9.5%). However, as shown in Table 32 and Figure 25 very small proportion of the respondents use pit latrine (1.1%). All the facilities were on-site. There was no sewerage system in the city.

Table 32 Sanitation Coverage in Yenagoa

Sanitation Facility	Frequency	Percentage
Pit latrine	3	1.1%
VIP latrine	25	9.5%
Septic Tank	236	89.4%
Total	264	

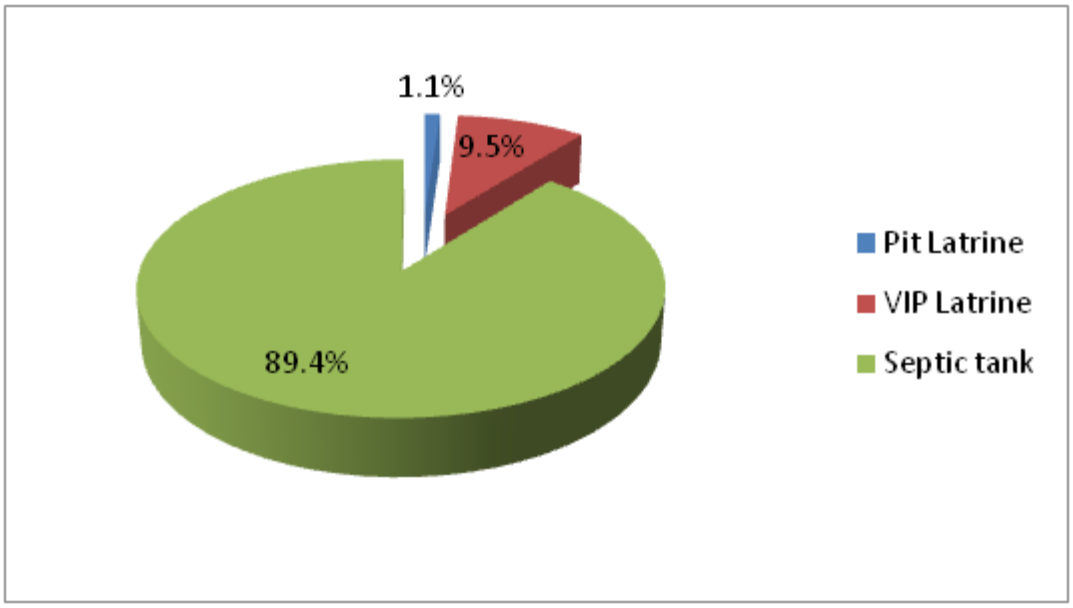


Figure 25 Yenagoa: Sanitation facilities used by respondents

3.1.4 Institutional and Legal Framework

3.1.4.1 Institutional and Legal Framework in Abuja

The objectives of the Abuja Environmental Protection Board (AEPB) include the following:

- To ensure the sustainability of the cleanliness of the environment in regards to sanitation.
- To monitor liquid waste and solid waste disposal
- To conserve natural resources
- To provide environmental monitoring
- To abate street hawkers, beggars etc.

The institution and legal frameworkto achieve the mission of the agency is backed by AEPB, Act 1997. In addition, FS should not be discharged in manholes that are not flowing. There are three designated manholes for discharging FS (two in Phase I, one in Phase II and one is proposed for Phase III). However, there is no strategic plan or policy for FSM in the city.

The Waste Water Treatment Plant, WUPA, Abuja is the central sewage treatment facility in Abuja. It was established in 2007 and has a daily capacity of 40,000m^3. Fecal sludge emptied from households by mechanical operators is discharge through manholes located strategically in the city and treated along with the domestic sewage.

3.1.4.2 Institutional and Legal Framework in Ibadan

The key stakeholders in FSM include:

- Oyo State Ministry of Environment and Habitat– Environmental Sanitation and Sewerage Department
- Sustainable Ibadan Project
- Municipal Local Government Environmental Health Services for the 5 LGAs
- Micro-Finance, Commercial and Development banks

Waste management in Ibadan (both solid and liquid) faces many challenges, primarily the proper collection and disposal of waste. As in most developing countries, the open dump approach is used for waste disposal in Ibadan. This occurs at the municipal disposal sites and several unofficial dumpsites scattered across the city. The environmental challenge with open disposal sites is the indiscriminate disposal of waste at these sites and the limited measures available to control operations. Institutional and legal frameworks are extremely fragile and the supporting waste management infrastructure has not kept up with rapid urbanization.

The Oyo State Ministry of Environment and Habitat's department of Environmental Sanitation and Sewerage (ESS) is responsible for both solid waste management and liquid waste management. The Ministry is responsible for the implementation of policies such as the National Environmental Sanitation Policy (2005) which specifies increasing management of sewage and excreta by 75% in 2010 and increasing private sector participation in the sanitation services by 75%. Each of the local government authorities has an Environmental Health Services (EHS) unit. The primary assignment of this unit is to detect environmental nuisances within the wards and abate such nuisances which include inspection of sanitation facility structures. The

unit also has a role in ensuring the waste management service providers comply with existing laws governing emptying and disposal. One of the EHS officers interviewed stressed that the shortage of attendants has minimized effective enforcement of regulations.

For liquid waste, Ibadan has one experimental disposal site (Sanyo) for fecal sludge although liquid waste from the industrial estate is also disposed at this site. Less than 15% of the fecal waste evacuated from households and commercial enterprises are disposed at this site.

3.1.4.3 Institutional and Legal Framework in Yenagoa

The State Ministry of Environment is responsible for the legal framework. In addition to implementing the Federal Policies and guidelines, the State also has some by-laws peculiar to the state.

3.1.5. Flow of money chart for FSM Transactions

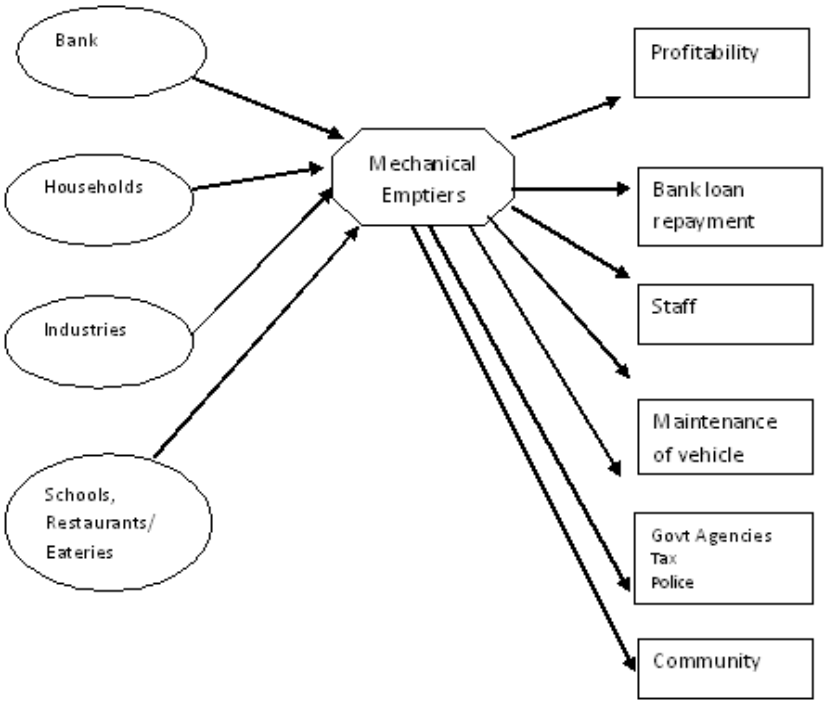


Figure 26 Money Chart for FSM Transactions

3.1.5.1 Flow of money chart for FSM Transactions in Abuja

FSM transactions starts from the household or industry to the point of discharge or treatment.

Monthly income and expenditure of respondents

The mean monthly income of respondents is USD 563.4 while the mean monthly expenditure was USD 371.1 (Table 33).

Table 33 Abuja: Monthly income and Expenditure of Respondents

		What is your monthly income (Local currency)	What is your monthly expenditure (Local currency)	What is your monthly income in USD	What is your monthly expenditure in USD
	N Valid	252	243	252	243
	No Response	549	558	549	558
Mean		84,512.70	55,670.78	563.42	371.14
Median		52,500.00	40,000.00	350.00	266.67
Mode		20,000	40,000	133.33	266.67
Std. Deviation		94,816.17	67,115.02	632.11	447.43
Minimum		4,000.00	2,000.00	26.67	13.33
Maximum		1,000,000.0	700,000.00	6,666.67	4,666.67

3.1.5.2 Flow of money chart for FSM Transactions in Ibadan

The flow of money chart for FSM operations in Ibadan is similar to that of Abuja except for the fact that one of the operators used cooperative society loan to purchase his trucks.

The mean monthly income of respondents is USD 188.6 while the mean monthly expenditure was USD 232.2

Table 34 Ibadan: Monthly income and Expenditure of Respondents

		Monthly income (Local currency)	Monthly expenditure (Local currency)	Monthly Income in USD	Monthly expenditure in USD
Mean		28,289.59	34,829.48	188.60	232.20
Std. Deviation		45,314.45	43,893.78	302.10	292.63
Minimum		1,000	1,000	6.67	6.67
Maximum		500,000	500,000	3,333.33	3333.33
N	Valid	685	597	685	597
	No Response	242	330	242	330

Table 35 Ibadan: Monthly Income of Respondents in USD grouping

		Frequency	Percentage
	< 200	532	57.4
	200-399.99	93	10.0
	400-599.99	27	2.9
	> 600	33	3.6
	Total	685	73.9
	No Response	242	26.1
Total		927	100.0

Table 36 Ibadan: Monthly Expenditure of Respondents in USD grouping

		Frequency	Percentage
	< 200	413	44.6
	200-399.99	97	10.5
	400-599.99	42	4.5
	> 600	45	4.9
	Total	597	64.4
	No Response	330	35.6
Total		927	100.0

3.1.5.3 Flow of money chart for FSM Transactions in Yenagoa

FSM transactions starts from the household or industry to the point of discharge or treatment.

Monthly income and expenditure of respondents

The mean monthly income of respondents was USD 329.95 while the mean monthly expenditure was USD 327.49 (Table 37).

Table 37 Yenagoa: Monthly Income and Expenditure of Respondents

		Monthly income (Local currency)	**Monthly expenditure (Local currency)**	**Monthly Income in USD**	**Monthly expenditure in USD**
Mean		49,492.48	49,124.11	329.95	327.49
Std. Deviation		62,070.15	54,151.05	413.80	361.00
Minimum		5,000	1,500	33.33	10.00
Maximum		45,0000	350,000	3,000	2,333.33
N	Valid	133	141	133	141

No Response	131	123	131	123

3.1.6 FS Emptying Business Owners' profile

3.1.6.1 Business Owners' Profile in Abuja

The mechanical emptiers in Abuja are small (1 truck fleet) and medium size (4 to 5 truck fleet) service companies. Three (3) out of the four operators provide emptying services as a secondary business. The operators had other businesses to complement the emptying business. For example, one of the operators provides fumigation services and also has a farm and yet another operator had a farm. Three of the operators are registered with the Abuja Environmental Board (AEPB) and licensed to provide services within AMAC (the metropolis). The registration with the AEPB allows the operators to garage their vehicles (if they so choose and at their own risk) on the AEPB premises. The AEPB premises also serves as a dispatching location where 'agents' being business to the operators. The fourth service provider is not registered with the AEPB and his customers are primarily outside AMAC. This is also his primary business and he has the largest truck fleet (5). Most operators indicated emptying services were infrequent and jobs not guaranteed especially the services provided to households.

3.1.6.2 Business Owners' Profile in Ibadan

The mechanical emptiers in Ibadan are small (1 truck fleet) and medium size (2 truck fleet) service companies. Four (4) out of the five operators provide emptying services as a secondary business. Most indicated the emptying services were infrequent and not guaranteed especially those provided to households. Two (2) of the operators have contracts with local manufacturing companies which guarantee business on a regular basis. Only one company provides emptying services as a primary business. This company has the largest truck fleet (4) and he has emptying service contracts with local manufacturing companies. The operators had other business ventures including equipment rentals for events, another was a full-time professor at the

University in town, another provided cleaning services and another was a medical doctor who owned a hospital. It is interesting to note that with the exception of the operator who does emptying as a primary business, all other operators started the business as a result of a customer need for which there was no existing service.

3.1.6.3 Business Owners' Profile in Yenagoa

The mechanical emptiers in Yenagoa are small (1 truck fleet) and medium size (2 truck fleet) service companies. All the five operators provide emptying services as a secondary business. Some of the operators were into other aspects of waste management e.g. solid waste and hazardous materials. At least two operators were also mechanics. Only one company had a formal arrangement with a couple of fast food restaurants to provide emptying services on a regular basis. Most operators indicated emptying services were infrequent and jobs not guaranteed, especially the services provided to households. If the trucks were not out doing evacuation rounds, the owners simply parked their trucks along the side of busy city access roads. In this case, the trucks acted as stationary advertising.

3.1.7 FSM Emptying Practices and Technologies: Manual and mechanical

3.1.7.1 FSM Emptying Practices and Technologies: Manual and mechanical (Abuja)

Figure 27 shows that of the 801 respondents interviewed, 43.2% claimed that their facilities were not yet full; 37% claimed that they empty their facilities immediately they are full. The others (11.7%) involving those connected to the central sewer claimed that when the Central sewerage system is blocked AEPB carried out the dislodging.

About 24% of the respondents claimed to empty their septic tank/pit mechanically, 18.6% manually, while 6% said they did not empty because thay are connected to the central sewer. However, more than half of the respondents (51.9%) did not respond (Figure 28).

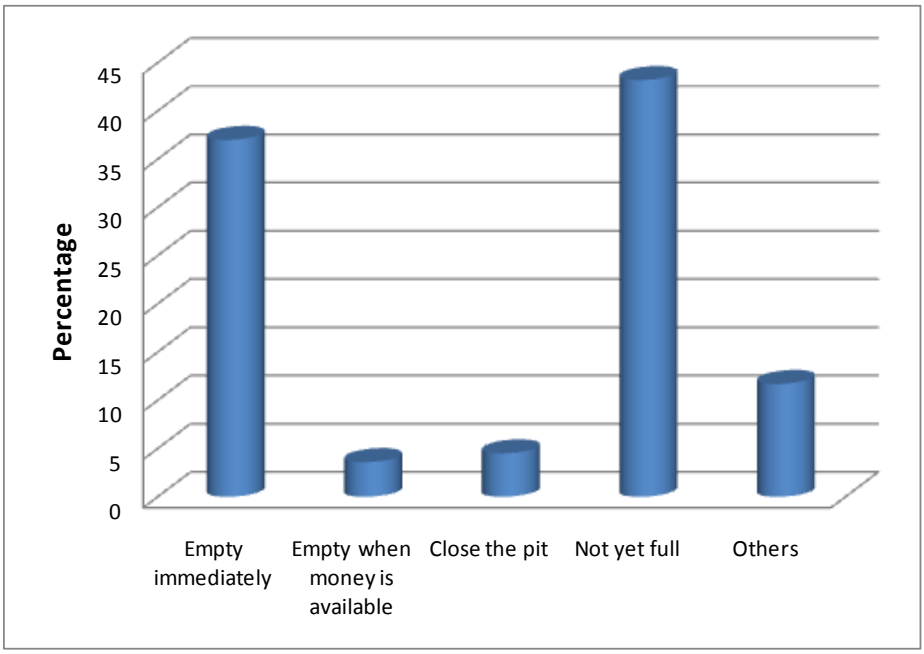


Figure 27 Abuja: Actions taken by Respondents when facility is full

The frequency of emptying the pit/septic tank ranged from once a year to once in a couple of years, e.g. 2, 3, or 4 years. Only a very small percentage (12%) of the respondents claimed that season could affect the frequency of emptying pits/septic tanks (Table 38).

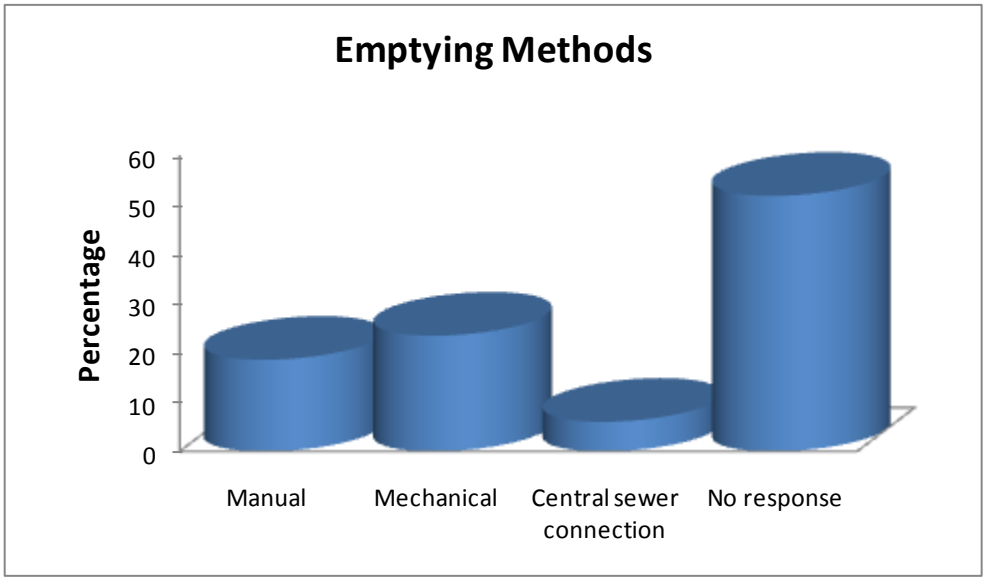


Figure 28 Abuja: Emptying Methods used by Respondents

Out of those who emptied manually, only a very small proportion (6.7%) claimed it was done by a family member. For those who responded to the question on emtying methods, the choice was driven by cost (17.9%), quality of service (34.0%), availability (34%), others -law/housing policy (13.2%). Mechanical emptiers that are registered receive referrals from the Abuja Environmental Protection Board (AEPB). Emptying service providers also inscribe their telephone numbers on their trucks thus making it easy for prospective clients to contact them.

Table 38 Abuja: Emptying Frequency for Pits/Septic Tanks

Emptying frequency	Frequency	%age
Twice a year	54	6.7
Once a year	133	16.6
Every couple of years	98	12.2
Others	100	12.5
No response	416	51.9
Total	801	100.0

Others: Once in 2 years, 3 times a year, 4 times a year, Once in 4 years, Once in 3 years, When blocked, as often as possible.

Emptying Fees and Willingness to Pay

The average prices repondents claimed to be paying for emptying for manual and mechanical emptying were USD 99.7 and USD 207 respectively. The averages do not correspond with the tariff fees given by the Emptiers. A more realistic statistic to use is the mode, which indicates the most frequent recurrent fee. The mode for manual emptying was approximately USD 67 and the mode for mechanical emptying was approximately USD 133 (Tables 39 to 41).

When asked if there is a need to improve fecal sludge management in their communities, 94.6% said “Yes“. Approximately 23% of the respondents said they were willing to pay an average of USD 46 (with a minimum and maximum of USD 1 and USD 247 respectively). Tables 42 and 43 provide the information.

Table 39 Abuja: Emptying Fees

	Fees for Manual emptying (USD)	Fees for Mechanical emptying (USD)
Mean	99.79	207.036
Median	80.00	133.33
Mode	66.67	133.33
Std. Deviation	122.27	187.39
Minimum	13.33	40.00
Maximum	1,200.00	1,000.00

Table 40 Abuja: Range of Fees for Manual Emptying (Grouping)

	Frequency	Percent
< 66.67	55	6.9
66.67-133.32	42	5.2
133.33-199.99	16	2.0
200-266.66	4	.5
> 266.66	3	.4
No Response	681	85.0
Total	801	100.0

Table 41 Abuja: Range of fees for Mechanical Emptying in USD (Grouping)

	Frequency	Percentage
< 66.67	23	2.9
66.67-133.32	38	4.7
133.33-199.99	36	4.5
200-266.66	35	4.4
> 266.66	34	4.2
No Response	635	79.3
Total	801	100.0

Table 42 Abuja: Willingness to pay for improved services

	Amount Respondents are willing to pay for improved services in USD
Mean	46.05
Median	20.00

Mode	6.67(a)
Std. Deviation	57.68
Minimum	1.33
Maximum	246.67

(a) Multiple modes exist. The smallest value is shown

Table 43 Abuja: Willing to pay for improved services (Grouping)

	Frequency	Percentage
< 66.67	141	17.6
66.67-133.32	16	2.0
133.33-199.99	16	2.0
> 200	8	1.0
No Response	620	77.4
Total	801	100.0

3.1.7.2 FSM Emptying Practices and Technologies: Manual and Mechanical (Ibadan)

A large percentage (66.9%) of the respondents claimed they empty their pit latrine/septic immediately they discover it is full (Figure 29).

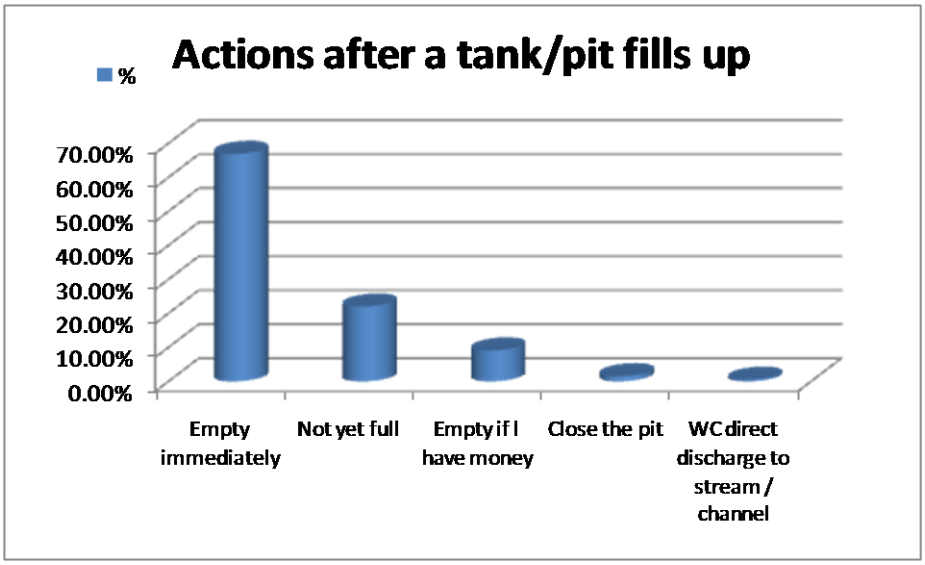


Figure 29 Ibadan: Actions taken by Respondents when facility is full

Figure 30 shows that majority of the respondents (65.6%) use manual emptying method; few (24.1%) people empty using mechanical method. However, 10.4% did not give any response. A large proportion (64.5%) of the respondents claimed to use manual emptiers while only 1.1% use family member. For those who responded to the question on emptying, the choice of emptying depends on availability (58.5%), cost (26.7%) and quality of service (14.8%). Mechanical emptiers that are registered receive referrals from the Ministry of Environmental and Habitat. Emptying service providers also inscribe their telephone numbers on their trucks thus making it easy for prospective clients to get in touch with them. For manual emptiers, households obtain information from their plumbers and other artisans.

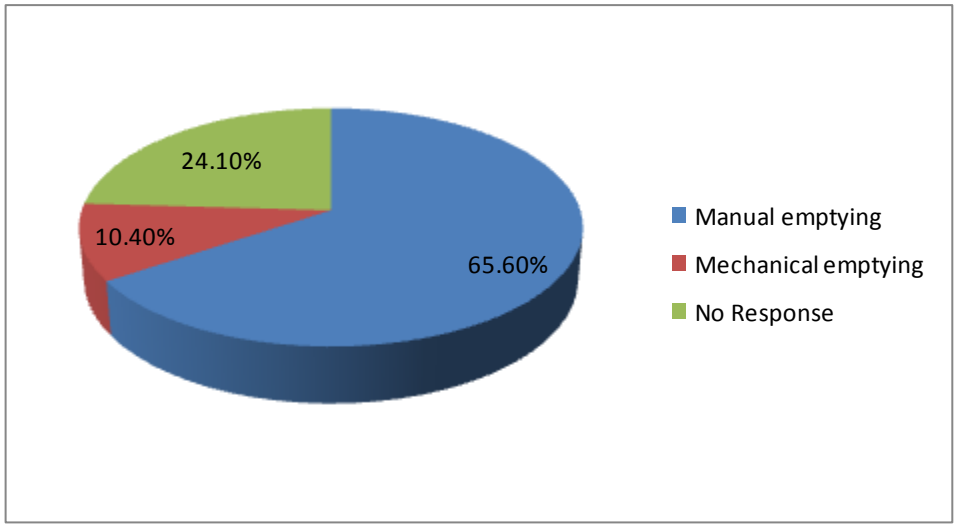


Figure 30 Emptying methods employed by the Respondents in Ibadan

The emptying frequency is shown in Table 44. Out of the number that responded to the question on frequency of emptying, 41.4% claimed they emptied their facilities every couple of years. About 11% emptied once in a year, while others constituting 21% of the respondents emptied their facilities once in 4 years to 12 years or when the facility is filled up. Almost the same number of respondents answered 'Yes' (35%) and 'No' (41%) to seasonal variation in emptying frequency of fecal sludge. However, 74.2% claimed they did not re-use the sludge. More than half of them (54.9%) bury the sludge beside their houses, 11.9% claimed it was taken away by the emptier, 7.8% discharged into the storm drains, while 1.8% had no idea. Out of the very small number of respondents (1.7%) that re-use the sludge, only 0.6% use it for agricultural purposes.

Table 44 Ibadan: Emptying Frequency for Pits/Septic Tanks

		Frequency	Percent
Valid	Twice a year	28	3.0
	Once a year	97	10.5
	Every couple of years	384	41.4
	Others	195	21.0
	Total	704	75.9

No response	223	24.1
Total	927	100.0

Emptying Fees and Willingness to Pay

The amount the respondents pay for both manual and mechanical emptying ranged from USD 6.7 to USD 400. The variation in price for both methods is shown in Table 45 and Table 46. About 68% of the respondents claimed that they are satisfied with the payment method, 7.8% were not, while 24.1% did not respond to the question. However, those who were not satisfied proposed paying in installments as an alternative to the present method.

Respondents were asked if they appreciate the quality of emptying services being provided at the moment. With the level of response shown in Figure 31, it was obvious that majority were happy. Those who were not happy with the quality of service complained that the sludge was not always completely evacuated.

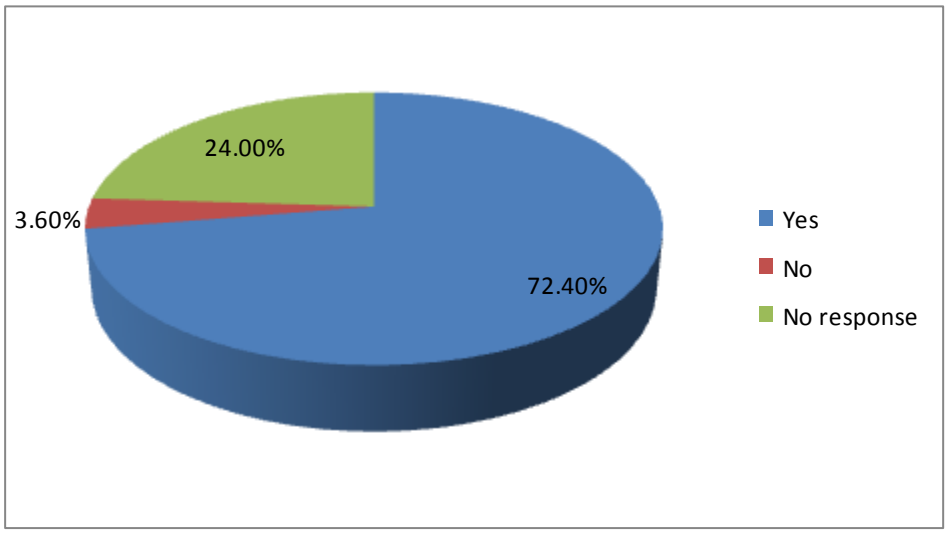


Figure 31 Ibadan: Appreciation of quality of service

Table 45 Ibadan: Amount paid for Manual Emptying in USD (Grouping)

Amount (USD)	Frequency	Percentage
< 6.7	384	41.4%
6.7 – 133.32	148	16.0%
133.33 – 199.99	38	4.1%
200 – 266.66	9	1.0%
>266.67	3	0.3%
No Response	345	37.2%
Total	927	100.0%

Table 46 Ibadan: Amount Paid for Mechanical Emptying (Grouping)

Amount (USD)	Frequency	Percentage
< 6.7	28	3.0%
6.7 – 133.32	24	2.6%
133.33 – 199.99	20	2.2%
200 – 266.66	12	1.3%
>266.67	5	0.5%
No Response	838	90.4%
Total	927	100.0%

Table 47 Ibadan: Description of the amount paid for the service

	Frequency	Percentage
Appropriate	476	51.3%
Too low	56	6.0
Too high	172	18.6
No Response	223	24.1

Total	927	100.0%

When asked what amount they were willing to pay for improving the service, more than half of the respondents (59.7%) said they were willing to pay below USD66 (Table 48)

Table 48 Ibadan: Amount respondents are willing to pay to improve services (Grouping)

	Frequency	Percentage
<66.67	553	59.7%
66/67 – 133.32	26	2.8%
133.33 – 199.99	16	1.7
200 – 266.66	8	0.9
>266.67	3	0.5
No Response	321	34.6%
Total	927	100.0%

3.1.8. Overview of WWTP, FSTP and Dump Sites

The features of the treatment plants in each of the cities are given in Table 49.

Abuja

Both wastewater and fecal sludge are channeled through the central sewer system and flow to the WUPA WWTP. FS evacuated from septic tanks are discharged into manholes connected to the main sewer or discharged into the bush. The plant was designed to receive wastewater generated by 1.2 million PE. The plant is currently receiving 0.7 million PE. Only 2 out of the 6 reactors are currently being utilised. It is anticipated that over the next 2 – 3 years, the plant will be fully utilised. The plant requires a constant supply of power 24/7 to operate. The plant is supplied electricity by an on-site 1300kw diesel generator. Currently, there is no methane recovery and utilisation for power generation taking place at the WUPA WWTP.

Ibadan

The Sanyo disposal site was originally designed to be an experimental station. The site receives wastewater from industrial sites and fecal sludge from household septic tanks. The total holding capacity of the stabilization tank is 12.5m^3. Any blockage in the tank's outlet pipe could lead to delays in the discharging process. It is estimated that the Sanyo disposal site receives an annual volume of 53,743m^3 of household and industrial wastewater including fecal sludge. There is no form of pre-treatment of the wastewater discharged at the site. The small amount of dried sludge recovered from the floating beds is used for small-scale faming on-site by residents in the neighbourhood. There is no energy recovery taking place on site.

Yenagoa

Yenagoa does not have a regulated disposal site for fecal sludge. Prior to 2007, the fecal sludge was discharged at an open site adjacent to the solid waste dumpsite. Construction of Tumbia road led to a change in disposal site location. The new disposal site is an open swampy piece of land by the roadside (a length of approximately 30 meters). The site is not regulated by any of the agencies. However, usage of the land is policed by the community that owns the land. The community charges the emptiers a disposal fee but there is no maintenance of the site.

Table 49 Overview of WWTP, FSTP and Dump Sites

FS Disposal Sites	Abuja	Ibadan	Yenagoa
Name of site	WUPA Wastewater Treatment Plant	Sanyo	Off Tumbia Road (Okolobiri)
Type of site	WWTP	FSTP	Open dump
Site ownership	Municipal	Municipal	Private
Capacity	1.2M PE	12m3	N/A
Pay use facility?	No	Yes	Yes
Payment frequency	Annual Registration fee	Annual Registration fee	Monthly fee to the community

			in addition to annual registration fees
Daily quantity of FS / WW received (m3)	40,000	146	Unknown
Distance from the city center (km)	15	18	25
# of trucks received daily at site	None	8	5
Technology type	Activated Sludge	Oxidation Pond	None
Pretreatment	Archimedes Screw Pumps X 3 Course screen: Removal of debris and waste larger than 5cm; Fine screen: Removal and dewatering of debris and waste larger than 4mm.	N/A	N/A
Grit chamber	Contains scraper bridge and sand classifier for the removal of sand and grease	N/A	N/A
Aeration:	Mamoth rotors initiate the oxygenazation process	N/A	N/A

Settling/thickening tank (number)	Clarifier tanks (6); Aeration basin (6); Gravity thickener (2)	1 stabilization tank: 2.5m (L)× 2.5 m (B) × 2m (D)	N/A
Drying bed	Sludge drying bed lagoons (4)	2X4 floating beds through which the FS passes before being discharged into the nearby stream (although only one set of 4 is operational – the second set is overgrown with weeds)	N/A
Others	Bio-reactors (6); Sludge dewatering system	1 manhole behind the stabilization tank which is used to check the FS flow into the beds and serves as a blockage clearing path	N/A

3.1.9 FS end re-use

3.1.9.1 FS end re-use in Abuja

Only 0.7% of the respondents claimed they re-used the FS for agricultural purposes (Table 50)

Table 50 Abuja: FS Reuse

	Frequency	%age
Yes	6	0.7
No	379	47.3
No response	385	51.9
Total	801	100.0

For those who did not re-use, FS was either carried away by emptier (14%) or buried under the ground (5.9%); 2% claimed they dumped in the drains (Table 51). Nevertheless, 43.3% of the respondents agreed that poor management of FS may have effect on water, health and environment.

Table 51 Existing Alternatives to FS Re-use

	Frequency	%age
Carried away by emptier	112	14
Buried under the ground	47	5.9
Dumped in the drain	16	2.0
No response	626	78.2
Total	801	100.0

3.1.9.2 FS End Re-use in Ibadan

The collected and disposed FS is not being used beneficially at the moment.

3.1.9.3 FS end re-use in Yenagoa

The collected and disposed FS is not being used beneficially at the moment.

3.2 Market Analysis per City

Various methods used for market analysis in the three cities are given in Tables 51 to 56. The first method (Method 1) was based on the standardized formula provided by the study proponents. The variables included:

- Proportion of on-site pit and septic tank facilities
- Emptying frequency of pit and septic tanks per year based on survey results
- Volume of septic tanks and pit facilities based on the dimensions in the survey results

The second method (Method 2) utilized the data points in Method 1 in addition to the FS generation per capita for both pits and septic tanks. The FS generation per capita was calculated based on the emptying frequency, the dimensions of the pit / septic tank and the number of people using the on-site sanitation facility. It was further assumed that each of the facilities would be completely evacuated when full.

Table 52 Method 1: FS Production per City

Method 1	**Abuja**	**Ibadan**	**Yenagoa**
2010 Number of households[1]	226,333	327,676	80,565
% of the city HH with On-site sanitation[2]	80%	84%	36%
Number of the city HH with On-site sanitation	181,509	275,248	28,957
% of the HH with on-site sanitation having pits in the city (*study survey results*)	25%	52%	11%
% of the HH with on-site sanitation having septic tanks in the city (*study survey results*)	43%	47%	89%
% of the HH with on-site sanitation connected to the central sewer in the city (*study survey results*)	30%		
Number of the HH with on-site sanitation having pits in the city (*study survey results*)	45,014	143,404	3,185

Number of the HH with on-site sanitation having septic tanks in the city (*study survey results*)	78,412	129,642	25,772
Typical volume of the septic tank (m^3)[3]	22	18	14
Typical volume of the pits (m^3)[3]	9	12	10
Total volume of fecal sludge emptied / year (m^3)	**1,247,193**	**1,829,663**	**218,022**

[1] *2010 Population projected from 2006 Census using UNFPA growth rates. The 2010 Household population was determined using the average number of persons per household from the study survey results*

[2] *Households with improved sanitation (Pits / Water Closet) - average from 2006 National Population Commission statistics*

[3] *Calculated based on the dimensions provided in the household surveys*

Table 53 Method 2: FS Production per City

Method 2	**Abuja**	**Ibadan**	**Yenagoa**
2010 Number of households[1]	226,333	327,676	80,565
% of the city HH with On-site sanitation[2]	80%	84%	36%
Number of the city HH with On-site sanitation	181,509	275,248	28,957
% of the HH with on-site sanitation having pits in the city (*study survey results*)	25%	52%	11%
% of the HH with on-site sanitation having septic tanks in the city (*study survey results*)	43%	47%	89%
% of the HH with on-site sanitation connected to the central sewer in the city (*study survey results*)	30%		
Number of the HH with on-site sanitation having pits in the city (*study survey results*)	45,014	143,404	3,185
Number of the HH with on-site sanitation having septic tanks in the city (*study survey results*)	78,412	129,642	25,772
FS generated per capita (litres / day) - Pit[3]	1.66	1.67	2.01

FS generated per capita (litres / day) - Septic tank[3]	4.28	1.49	2.76
Total VOLUME of fecal sludge emptied / year (m^3)	**447,847**	**341,178**	**77,719**

[1] 2010 Population projected from 2006 Census using UNFPA growth rates. The 2010 Household population was determined using the average number of persons per household from the study survey results

[2] Households with improved sanitation (Pits / Water Closet) ~ average from 2006 National Population Commission statistic

[3]Calculated based on the # of users, emptying frequency and pit dimensions provided in the household surveys

Across the three cities, the results from method 2 were much lower than the results from Method 1. It is believed that FS production per city probably lies somewhere between the results from Method 2 and Method 1. The approach used in Method 2 is similar to the widely accepted approach used to determine the amount of solid waste generated in a city i.e.

Solid waste generated per city per day (kg) = Average waste generation rate per capita per day (kg) * city population

In Abuja, the FS production per capita per day for Pits was determined to be 1.66 per capita per day (litre) and 4.28 per capita per day (litre) for Septic tanks. These rates were determined based on the volume of the pit / septic tank, the frequency of evacuation and the number of people using the toilet facility.

In Ibadan, the FS production per capita per day for Pits was determined to be 1.67 per capita per day (litre) and 1.49 per capita per day (litre) assumed for Septic tanks. These rates were calculated based on the volume of the pit / septic tank, the frequency of evacuation and the number of people using the toilet facility. It seemed an unusual coincidence that the generation rate per capita for septic tanks was almost the same as that for pits in Ibadan. The plausible reason for this similarity of generation rates could be bad data or the inadequate water supply situation is driving many WC systems to function as pseudo pit latrines.

In Yenagoa, the FS production per capita per day for Pits was determined to be 2.01 per capita per day (litre) and 2.76 per capita per day (litre) for Septic tanks. These rates were calculated based on the volume of the pit / septic tank, the frequency of evacuation and the number of people using the toilet facility.

It is interesting to note that Abuja had the highest FS per capita generation rate for Septic tanks across the three cities. One explanation for this difference could be the fact that Abuja has a functioning public water supply system whereas the other cities do not. The water closet systems in the other systems may just be functioning as pour flush systems or pseudo pit latrines due to the problems of water supply. For households with private water supply systems e.g. borehole connections, the intermittent power supply situation in Nigeria would make pumping water to supply overhead tanks an infrequent activity conducted by households.

Based on the emptying frequency for septic tank facilities derived from the household survey results and extrapolated to the household population of Abuja, 23% is collected by the registered mechanical emptiers. This would imply 77% of the septic tank evacuations are carried out by informal emptiers or the emptying data provided by the emptiers is understated. It is also assumed that on average the informal emptiers make one trip per household. Based on observations during the truck routing and admissions made the emptiers, it is estimated that 1 out of 5 trips (20%) are discharged in the bush and not at the authorised manholes due to distance. The informal operators dispose their FS loads in open dumpsites or drainage channels 100% of the time since they are not authorised to discharge in the manholes connected to the WUPA WWTP sewer trunk lines. It is also important to note that the volumes collected by the manual operators are typically buried within the household premises or dumped into nearby water channels.

Table 54 Abuja: Annual Fecal Sludge Collection

Abuja FS Collection (Household)	**Company A**	**Company B**	**Company C**	**Company D**	**Informal Mechanical Emptiers****	**Manual Emptiers****	**Total**

# of Household trips (Annual)	4,800	144	720	5,760	38,160	17,372	**66,956**
Truck capacity (m^3)	12	12	10	9	6	9	
Total vol. collected (m^3)*	55,200	1,728	7,200	48,960	228,960	148,792	**490,840**
Total vol. discharged in sewer network trunk (m^3)	44,160	1,382	5,760				**51,302**
Total vol. discharged in open dumpsites (m^3)	11,040	346	1,440	48,960	228,960	148,792	**439,537**

**assumes a full truck load for each trip*

***derived based on results of emptying frequency*

Based on the emptying frequency for septic tank facilities derived from the household survey results and extrapolated to the household population of Ibadan, only 4% is collected by the registered mechanical emptiers. This would imply 96% of the septic tank evacuations are carried out by informal emptiers or the emptying data provided by the emptiers is understated. It is also assumed that on average the informal emptiers make one trip per household. With no explicit incentives or penalties for registered operators to dispose at the Sanyo facility, it is assumed that 1 out of 4 trips (25%) are discharged in the bush and not at the disposal site. The informal operators are likely to dispose of the collected FS in open dumpsites or drainage channels 100% of the time since they are not permitted to discharge at the Sanyo facility. It is important to note that the volumes collected by the manual operators are typically buried within the household premises or dumped into nearby water channels or nearby drainage channels.

Table 55 Ibadan: Annual Fecal Sludge Collection

Ibadan FS Collection (Household)	Company B	Company C	Informal Emptiers**	Manual Emptiers**	Total
# of Household trips (Annual)	960	1,439	52,942	67,313	**122,654**
Truck capacity (m^3)	6	12	5	12	
Total vol. collected (m^3)*	5,760	16,549	264,710	807,754	**1,094,772**
Total vol. discharged at Sanyo disposal site (m^3)	4,320	12,411			**16,731**
Total vol. discharged in open dumpsites (m^3)	1,440	4,137	264,710	807,754	**1,078,041**

**assumes a full truck load for each trip*

***derived based on results of emptying frequency*

Based on the emptying frequency for septic tank facilities derived from the household survey results and extrapolated to the household population of Yenagoa, only 4% is collected by the registered mechanical emptiers. This would imply 96% of the septic tank evacuations are carried out by informal emptiers or the emptying data provided by the emptiers is understated. It is also assumed that on average the informal emptiers make one trip per household. All evacuated fecal sludge is disposed of in the bush or nearby water channels. This activity applies to both licensed and informal emptiers. It is important to note that the volumes collected by the manual operators are typically dumped into nearby water channels.

Table 56 Yenagoa: Annual Fecal Sludge Collection

Yenagoa FS Collection (Household)	Comp A	Comp B	Comp C	Comp D	Comp E[2]	Informal Emptiers[3]	Manual Emptiers[3]	Total

# of Household trips (Annual)	24	360	36	72	48	13,360	2,271	**16,171**
Truck capacity (m^3)	8	10	10	7	10	10	9	
Total volume collected (m^3)[1]	192	3,600	360	504	480	133,600	20,436	**159,172**
Total vol. discharged in open dumpsites / water channels (m^3)	192	3,600	360	504	480	133,600	20,436	**159,172**

[1]*assumes a full truck load for each trip*

[2]*proxy used for the emptier who refused to be interviewed*

[3]*derived based on results of emptying frequency*

3.3 Service Delivery Models Review

3.3.1 Overview of Existing Models

Of the 3 cities surveyed, only Abuja has a public sewer network. Ibadan does not have a public sewer system. However, there are at least four private central sewerage systems serving the University of Ibadan, the International Insititute for Tropical Agriculture (IITA), University College Hospital and British American Tobacco Nigeria in Ibadan. Across Abuja, Ibadan and Yenagoa, majority of the city households have individual septic tanks connected to WCs or pit latrines (see Table 52). Evacuation of these sanitation facilities are carried out by either manual emptiers or mechanical emptiers.

Manual Emptying

The household contacts a manual emptier to evacuate the on-site pit or septic tank and dispose of the evacuated fecal waste. The manual emptier arrives on-site with a shovel, digger, buckets, rope and chemicals (optional) and the household negotiates the amount to be paid for the service based on the size of the pit. Once the price has been agreed, the emptier excavates a

second pit on-site for burying the evacuated waste from the pit latrine or septic tank. If the site is land constrained, the emptier transports the waste (on foot) to the nearest stream. Of the 3 cities surveyed, Ibadan has the highest number of pit latrines. According to the Ibadan survey results, 87.3% of the households evacuated bury the FS on site, while 10.3% discharge the evacuated FS into nearby streams. There is no active reuse of fecal waste collected by the manual emptiers across all the cities surveyed. It is important to note that the manual emptiers are not recognized as legitimate service providers by the Ministry of Environment.

Mechanical Emptying

The household contacts the mechanical emptier to evacuate the on-site septic tank(s). The operator charges the household per trip regardless of whether the tank is filled to capacity. All of the mechanical emptiers restrict evacuation to septic tanks only - no pit latrines. The mechanical operator arrives on site with a sewage truck and hoses. The prerequisite to providing on-site service is that the area where the household is located be motor-able or alternatively, the hoses have to be long enough to reach the house from the point at which the roads are no longer motor-able. The registered (licensed) emptiers transport the waste to the approved disposal locations while the informal operators discharge the waste into the bush.

3.3.2. Comparison with Solid Waste Management Service Models

Unlike solid waste management, liquid waste management seemed to have little to no active involvement by the Ministries of Environment in Ibadan and Yenagoa. In contrast the Abuja Environmental Protection Board (AEPB) has separate departmental units handling solid waste management unit and liquid waste management.

In Ibadan, the main focus of the Ministry of Environment and Habitat and the Oyo State Solid Waste Management Authority (OSWMA) has been and continues to be on solid waste management because of its high visibility and the fact that Ibadan has the non-enviable reputation of being the dirtiest city in Nigeria. OSWMA owns and manages four active municipal dumpsites for solid waste in Ibadan (Abaeku, Ajakagan, Awotan and Lapite) which

have all been in existence for at least 12 years. For liquid waste, the Oyo State Ministry of Environment and Habitat owns and manages one municipal site in Ibadan, Sanyo, which was originally designed to be an experimental station in 2008. The Ministry is also responsible for registering both solid waste and liquid waste service providers and licensing them to operate within the city of Ibadan. The Refuse Contractors are required to pay an annual registration fee of N20,000 (USD 133) in the residential zone and N30,000 (USD 200) in commercial/industrial zones. It is important to note that for liquid waste, only the mechanical emptiers are recognized as legitimate service providers. The services provided by the manual emptiers are not considered legal.

Under the Ministry is the Oyo State Waste Management Authority (OSWMA) which is responsible for managing solid waste collection and disposal in the Ibadan municipal. OSWMA works hand in hand with private refuse contractors to provide solid waste management services in Ibadan. There are presently 140 Private Refuse Contractors (PRCs) registered with the Oyo state Waste Management Authority. OSWMA handles the public zones while the residential and commercial zones are handled by private refuse contractors on a fee basis. The private contractors have a governing association, the Refuse Contractors Association, providing a legal umbrella for all members of the association. On the other hand, there is no liquid waste management authority and activities in this sector have been carried out primarily by the private sector with minimal government intervention. A comparative analysis of these models in Ibadan is shown in Table 57.

Similarly, in Yenagoa the main focus of the Ministry of Environment is on solid waste management. The Ministry has one approved solid waste disposal site on Tombia road. For liquid waste, the Ministry of Environment has directed the emptiers to use an open piece of land in one of the communities. The Ministry does not manage this disposal site.

Table 57 Ibadan: Solid Waste vs. Fecal Waste Models

Ibadan	Solid Waste	Fecal Waste
Activities	Collection and Disposal	Collection and Disposal
Service Providers	Government and Private	Private
Annual registration fee	Residential: NGN 20,000 (USD133) Commerical:NGN30,000 (USD200)	NGN20,000 (USD133)
Collection fleet	Government and Private	Private
Public Private Partnership	Yes	No
No. of functioning dump trucks (government owned)	> 36	0
Collection method	Manual	Manual and Mechanical
Minimum frequency of collection	Daily	Monthly
Zoned collection	Yes	No
Mandated collection/emptying frequncy	Yes	No
Dumpsite ownership	Municipal	Municipal
# of approved active dumpsites	4	1
Collection (Emptying) fee	Yes	Yes
Pay per service	No	Yes
Monthly Tipping/Disposal fee	Yes	No
Reuse / Recycling of Waste	Yes through informal scavenging	On very rare occasions for farming
Unapproved dumpsites locations?	Yes	Yes

The Public Private Partnership (PPP) in Solid Waste Management seems to be working fairly well in Ibadan and it is believed that perhaps this model can also be replicated in Fecal Waste Management. A key component of the Private partnership is the umbrella association for the refuse contractors. This type of umbrella organization does not exist currently for the Fecal Waste contractors in neither of the three cities surveyed. This type of organization would need to be formed if a similar PPP were to be replicated in this sector. In 2010, the state government purchased +20 new waste disposal trucks for waste collection. The plan was to lease these new trucks to private refuse collectors to operate. Similarly, the 12 local governments in Ibadan also purchase one new truck each to collect waste within the local government areas. These trucks were to be operated by the government and not the private sector. For the PPP to be 100% effective, the government needs to provide capable and accountable resources to ensure better enforcement of environmental laws and provision of adequate transfer stations and disposal sites. The attitude of most residents in Ibadan is that solid waste management ought to be a social service. As a result people refuse to pay for solid waste collection and disposal and since there no penalties people prefer to dump waste indiscriminately out in the open.

The solid waste PPP model can be replicated for fecal waste in Ibadan and Yenagoa. However, the challenges with the government sector holding up their end of the bargain still remain. The enabling physical structures (e.g. transfer stations, FSTPs) do not exist currently and the structure that does exist is clearly inadequate (Sanyo). In Abuja, there seems to be a semblance of a PPP model in operation.

3.4 Financial and Business Model analysis

3.4.1 Demand and supply in each city

The demand and supply analysis of the facilities in each city is shown in Tables 52 to 56.

Abuja

Abuja has a central sewerage system and approximately 30% of the city population is connected to the central sewer network. The remaining 70% have septic tanks or pit latrines and when these are filled to capacity, they need to be evacuated either mechanically or

manually. Of the households surveyed, approximately 77% of the households were satisfied with their toilet facilities. Reasons given by the 23% who are dissatisfied with existing toilet facilities include the following:

- The toilet fills up quickly
- Poor management
- Too far from the apartment
- Not sufficient for the needs of the household
- Frequent blockages which cause overflows in the environment and underground water contamination

According to the household survey results, a toilet faciity is utilised by an average of 14 persons. The private sector is primarily responsible for the emptying and transportation of fecal waste with oversight provided by the Abuja Environmental Protection Board (AEPB). The two main service providers for the evacuation, transportation and disposal of fecal sludge from the household pit latrines and septic tanks are the manual emptiers and mechanical emptiers. Manual emptiers evacuate the pit latrines / septic tanks and dispose of the waste on-site. Of the households requiring emptying service, the survey results showed that approximately 44.2% of the households patronise manual emptiers (for pit emptying). While approximately 55.8% of the households patronise mechanical emptiers. The existing mechanical emptiers evacuate only septic tanks and the fecal sludge is transported and discharged in authorised manholes connected to the sewer trunk.

The mechanical emptiers in Abuja only provide services to households with septic tanks. There are three known registered mechanical emptiers and one (1) known informal emptiers. In addition there are a few company owned and operated emptiers e.g. Julius Berger who provide emptying services for their company owned locations. Occasionally they do provide services to outsiders. According to NPC 2006 statistics, households with

septic tanks make up 43.2% of the household population with access to improved sanitation in Abuja.

Ibadan

Ibadan does not have a central sewerage system. As such when household pit latrines and septic tanks fill up, they need to be evacuated either manually or mechanically. Of the households surveyed, approximately 67% of the households were satisfied with their toilet facilities. Reasons given by the 33% who are dissatisfied with existing toilet facilities include the following:

- Unhygienic
- Poor management
- No other suitable alternatives
- Not sufficient for the needs of the household
- Shortage / scarcity of water

According to the household survey results, a toilet faciity is utilised by an average of 18 persons. This is partly due to the fact that a particular house could have several households using one or two available toilets in the house. With very little government intervention in the area of liquid waste management, the private sector is primarily responsible for this aspect of waste management. The two main service providers for the evacuation, transportation and disposal of fecal sludge from the household pit latrines and septic tanks are the manual emptiers and mechanical emptiers. Manual emptiers evacuate the pit latrines / septic tanks and dispose of the waste on-site. The survey results show that approximately 86.4% of the households surveyed patronise manual emptiers who empty both pit latrines and septic tanks. Approximately 13.6% of the households patronise mechanical emptiers. The existing mechanical emptiers evacuate only septic tanks and the fecal sludge is transported and disposed at an off-site location.

The mechanical operators in Ibadan only provide services to households with septic tanks. According to NPC 2006 statistics, households with septic tanks make up 44% of the household population with access to improved sanitation in Ibadan. Based on survey results, the household coverage for mechanical emptying is 13.6%. This translates to approximately 36,925 households that have been serviced by mechanical operators (66% of the total 2010 septic tank population that needs to be emptied annually). It is unclear how the remaining 19,022 septic tanks are currently being emptied. It can be assumed the emptying is either being done by manual emptiers or the septic tanks are discharged directly into nearby water channels.

Yenagoa

Similar to Ibadan, Yenagoa does not have a central sewerage system. As such when household pit latrines and septic tanks fill up, they need to be evacuated either manually or mechanically. Of the households surveyed, approximately 77% of the households were satisfied with their toilet facilities. Reasons given by the 23% who are dissatisfied with existing toilet facilities include the following:

- Poor management
- No other suitable alternatives
- Too far from the apartment
- Fills up quickly

According to the household survey results, a toilet faciity is utilised by an average of 14 persons. This is partly due to the fact that a particular house could have several households using one or two available toilets in the house. The private sector is primarily responsible for managing fecal waste collection and disposal. The two main service providers for the evacuation, transportation and disposal of fecal sludge from the household pit latrines and septic tanks are the manual emptiers and mechanical emptiers. Although a smaller household proportion (30%) utilise manual emptiers compared with Ibadan and Abuja. Manual emptiers evacuate the pit latrines / septic

tanks and dispose of the waste in nearby water channels or bury it within the household premises. The existing mechanical emptiers evacuate only septic tanks and the fecal sludge is transported and disposed at an off-site location.

Tables 58 to 664 show the current 2010 sludge production and the projections out to 2016. This was calculated using the two methods highlighted in section 3.2. The tables show the sewage truck gap /surplus in the surveyed cities using both methods for calculating the FS produced. It is important to note that the truck gap/surplus for Abuja did not include the (3) government utility trucks. It was assumed that on average each truck could make a total of 4 trips per day. The truck capacity listed for each city is a computed average of the existing truck capacities. The 2016 projections also assumed the current vehicle fleets for each operator would remain unchanged. The projections assumed there would be new truck purchases, however, the new purchases would be replacements for trucks going out of commission. The looming decision in Nigeria to potentially remove the existing fuel subsidy will serve as a deterrent to private contractors increasing their vehicle fleet.

Table 58 Services Demand Profile 2010

2010 Profile	Abuja	Ibadan	Yenagoa
2010 Household Population[1]	226,333	327,676	80,565
Average Septic tank vol. (m^3) *(survey results)*	22	18	14
Average Pit tank vol. (m^3) *(survey results)*	9	12	9
# Pits Emptied/year	17,372	69,461	2,271
# Septic tanks Emptied/year	49,584	55,341	13,900
Annual FS vol. (m^3) emptied / year (Method 1)	1,247,193	1,829,663	218,022

Annual FS vol. (m^3) emptied / year (Method 2)	447,847	341,178	77,719

[1] *2010 Population projected from 2006 Census using UNFPA growth rates. The 2010 Household population was determined using the average number of persons per household from the study survey results*

Table 59 Sewage Truck Gap Analysis - FS Method 1 (2010)

FS Production Method 1 (2010 Profile)	Abuja	Ibadan	Yenagoa
Septic tank volume Emptied/year (m^3)	1,090,848	996,130	194,607
Average daily septic tank volume evacuated (m^3)	2,989	2,729	533
Average truck capacity (m^3)	10.5	6.4	10
Average # of trips per truck per day	4	4	4
# of trucks required daily for septic tank evacuation	72	107	14
# of private trucks in service	12	5	6
# of government utility trucks in service	3		
Truck Gap / Surplus[1]	60	102	8

[1] *Does not include unknown informal emptiers and does not include government utility trucks*

Table 60 Sewage Truck Gap Analysis - FS Method 2 (2010)

FS Production Method 2 (2010 Profile)	Abuja	Ibadan	Yenagoa
Septic tank volume Emptied/year (m^3)	394,272	141,757	69,457
Average daily septic tank volume evacuated (m^3)	1,080	388	190
Average truck capacity (m^3)	10.5	6.4	10

Average # of trips per truck per day	4	4	4
# of trucks required for daily septic tank vol. evacuation	26	16	5
# of private trucks in service	12	5	6
# of government utility trucks in service	3		
Truck Gap / Surplus[1]	14	11	1

[1] *Does not include unknown informal emptiers and does not include government utility trucks*

Table 61 Services Demand Profile 2016

2016 Projections	Abuja[1]	Ibadan[2]	Yenagoa[3]
Household Population	395,444	401,828	95,876
Average Septic tank vol. (m3)	22	18	14
Average Pit tank vol. (m3)	9	12	9
# Pits to be Emptied/year	30,351	85,180	2,702
# Septic tanks to be Emptied/year	86,632	67,864	16,542
Annual FS vol. (m^3) to be emptied / year (Method 1)	2,179,064	2,243,713	259,459
Annual FS vol. (m^3) to be emptied / year (Method 2)	782,467	418,386	92,490

Table 62 Sewage Truck Gap Analysis - FS Method 1 (2016)

FS Production Method 1 (est 2016)	Abuja[1]	Ibadan[2]	Yenagoa[3]
# Septic tank volume to be Emptied/year	1,905,903	1,221,553	231,593
Average daily septic tank vol. to be evacuated (m^3)	5,222	3,347	635

Average truck capacity (m^3)	10.5	6.4	10
Average # of trips per truck per day	4	4	4
# of trucks required daily for septic tank evacuation	125	131	16
# of private trucks in service	12	5	6
Truck Gap / Surplus[4]	113	126	10

Table 63 Sewage Truck Gap Analysis - FS Method 2 (2016)

FS Production Method 2 (est 2016)	Abuja[1]	Ibadan[2]	Yenagoa[3]
# Septic tank volume to be Emptied/year (m^3)	688,862	173,836	82,657
Average daily septic tank vol. to be evacuated (m^3)	1,887	476	226
Average truck capacity (m^3)	10.5	6.4	10
Average # of trips per truck per day	4	4	4
# of trucks required for daily septic tank vol. evacuation	45	19	6
# of private trucks in service	12	5	6
Truck Gap / Surplus[4]	33	14	0

[1] projected +9.2% annual population growth rate from UNFPA statistics
UNFPA projections for FCT Abuja http://nigeria.unfpa.org/abuja.html
[2] projected 3.46% annual population growth rate from UNFPA statistics
UNFPA projections for Oyo State http://nigeria.unfpa.org/oyo.html
[3] projected 2.94% annual population growth rate from UNFPA statistics
UNFPA projections for Bayelsa State http://nigeria.unfpa.org/bayelsa.html
[4] Does not include unknown informal emptiers

3.4.1.1 Company level financial analysis

Small Mechanised Services

In Abuja, there are two companies registered with the Abuja Environmental Protection Board (AEPB) each having one truck. There are licensed to provided services within the city and authorised to discharge their waste in designated manholes connected to the Sewer trunk.

In Ibadan, there are two companies not registered with the Ministry of Environment that are currently providing emptying services. The businesses each have one truck. Unfortunately, the operators were reluctant to divulge information on their operations. Company "D" which claimed to be registered was unwilling to divulge any financial data related to operations. The same applied to Company "E", an informal operator, who was suspicious of the motives behind the data collection exercise. It was later learned from a registered operator that the Ministry had threatened to impose a NGN100, 000 (USD 667) fine on the non-registered operators.

In Yenagoa, there are 4 small mechanical emptier companies each having one truck.

Medium Mechanised Services

In Ibadan, there are three registered companies ("A", "B" and "C") having between 2 to 3 trucks in operation. Each of the companies provided some level of financial data on their emptying operations. It is important to note that Company "C" has ceased operations and no longer has a truck fleet. The information provided was as of when the company was still in operation until November 2010 prior to the temporary closure of the dumpsite.

Large Mechanised Services

Across the 3 cities surveyed, there are no mechanical emptiers with truck fleets exceeding 5 trucks.

3.4.1.1.1 Income statements

Two income statements are presented for the Abuja and Ibadan mechanical emptiers using two tax rate scenarios (Tables 65, 66, 68 and 69). The businesses interviewed did not keep formal or audited financial statements and even if they did were not willing to share their financial statements with the team. Across the three cities, it was quite evident that the business owners had other businesses they were running and sewage evacuation was not their sole source of income. For the purpose of this study, it was assumed that the businesses were paying taxes on the profits generated. The business tax rate is 30% while VAT which is to be charged on sales of goods and services is a mandated 5%. These two proxy tax rates were applied in each of the income statements with the exception of Yenagoa where majority of the operators were running losses. Only one operator was making a profit and the 30% tax rate scenario was applied to his income statement. It was also observed during the truck routings that the drivers do not typically report all the trips made to the business owner. This typically occurs when the truck driver is flagged down while en-route by a potential client. In these situations, the driver will complete the original assignment he was dispatched to do and then follow-up with the new customer afterwards. The new customer will not be reported to the business owner in most cases. Unfortunately, such situations result in diversion of revenue from the company's bottom line.

Abuja

In Abuja, all (Companies "A", "C" and "E") but one of the companies (Company "B") is profitable on a USD basis (Tables 65 and 66). It is interesting to note that similar to company "C" in Ibadan providing services to households, company "B"' also has a truck with a capacity of $12m^3$. This implies that for every 1.5 to 2 trips made by his competitors, he only makes one and still charges the same price charged by his competitors with smaller capacity trucks. With 30% of the Abuja population connected to the central sewer, the operators are left to compete for the 70% that are not connected to the sewer. The public utility, AEPB, play an oversight role for sewage management services provided in the city. It was evident that the private operators played a dominant role in the provision of these services although the AEPB also has its own fleet of trucks (3). The AEPB also has two sewage trucks on retainer-ship. The private operators also informed the team that the AEPB sometimes leases trucks from them to provide evacuation services to the public. In the instances when this arrangement occurs, the AEPB pays the operator a per day rate for the use of the vehicle. The AEPB, however, charges its customers on a per

volume basis (USD 13.3/m^3) for household evacuation and (USD 33.3/m^3) for commercial evacuation. The AEPB has three trucks of different capacities (6m^3, 10m^3 and 50m^3).

Table 64 Abuja Company Operational Data

Abuja	Company A	Company B	Company C	Company E
Exchange rate 1USD – NGN	150	150	150	150
Average total # of trips / year	6,864	360	888	8,916
Average total # of trips / month	572	30	74	743
Average # of Household trips / year	4,800	144	720	5,760
Average # of Household trips / month	400	12	60	480
Average tariff (USD)	77	81	73	119
Average fleet truck capacity (m^3)	22	12	10	7
Truck depreciation rate (# of years)	5	5	5	5
# of trucks	5	1	1	5
Operation days / week	6	6	6	7

Table 65 Abuja Mechanical Emptiers - Income Statement using 30% tax rate

Abuja	Company A		Company B		Company C		Company E	
Item	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)
Personnel Costs								
Wages paid:								
Permanent staff	24,000	3	7,680	21	12,960	15	267,480	30
Commission Paid	23,400	3	0	0	0	0	0	0
Dump Site Security	0	0	0	0	0	0	0	0
Police commission	0	0	0	0	0	0	0	0
Social Contribution to permanent staff	0	0	0	0	0	0	0	0
Medical expenses	0	0	400	1	0	0	467	0

Subtotal	**47,400**	**7**	**8,080**	**22**	**12,960**	**15**	**267,947**	**30**
Operating and dumping costs								
Registration fees of company	467	0	667	2	667	1	500	0
Licensing fees for truck	2,333	0	333	1	467	1	233	0
Office building rent	6,667	1	1,000	3	0	0	0	0
Telephone	2,400	0	0	0	800	1	1,600	0
Electricity	0	0	100	0	0	0	0	0
Water	0	0	0	0	0	0	0	0
Offices supplies, computer	0	0	0	0	0	0	0	0
Truck Maintenance / Repairs	4,800	1	0	0	4,000	5	6,800	1
Truck servicing	8,000	1	533	1	667	1	1,600	0
Pump servicing	2,400	0	533	1	0	0	0	0
Safety Equipment	320	0	667	2	400	0	0	0
Fuel (pumping & transport)	55,440	8	8,580	24	12,835	14	39,600	4
Sludge dumping/tipping Fees	0	0	0	0	0	0	0	0
Dump Site Maintenance	0	0	0	0	0	0	0	0
Steam Cleaning	0	0	0	0	0	0	0	0
Tires	11,667	2	2,080	6	217	0	2,880	0
Suction pipes	267	0	267	1	300	0	0	0
Radio Advertising	3,200	0	2,000	6	0	0	0	0
Subtotal	**97,960**	**14**	**16,760**	**47**	**20,352**	**23**	**53,213**	**6**
Equipment Capital costs								
Loan Interest paid to Bank	6,531	1	0	0	0	0	0	0
Insurance costs for trucks, vehicles	3,833	1	0	0	1,200	1	0	0
If used, costs to refurbish truck (one time- upfront)	0	0	2,667	7	1,667	2	0	0
Truck Depreciation Cost	40,000	6	8,667	24	7,067	8	24,000	3
Tires annual depreciation Cost	0	0	0	0	0	0	0	0

Suction pipes depreciation Cost	0	0	0	0	0	0	0	0
Office equipment depreciation costs	0	0	0	0	0	0	0	0
Vehicle rental cost	0	0	0	0	0	0	0	0
Subtotal	**50,365**	**7**	**11,333**	**31**	**9,933**	**11**	**24,000**	**3**
Revenue Sources								
Emptying (Households only)	384,000	56	12,480	35	48,000	54	768,000	86
Emptying (Hospitals)	9,600	1	1,040	3	0	0	0	0
Emptying (Religious Centres)	64,000	9	2,080	6	0	0	168,000	19
Emptying (Public toilets)	0	0	6,400	18		0	10,800	1
Emptying (Schools)	28,800	4	1,040	3	6,000	7	100,800	11
Emptying (Companies)	40,800	6	3,120	9	6,000	7	36,000	4
Emptying (Eateries)	0	0	3,120	9	4,800	5	0	0
Leasing of truck to AEPB	1,800	0	450	1	0	0	0	0
If sold for re-use: Income from sale to buyer	0	0	0	0	0	0	0	0
Subtotal	**529,000**	**77**	**29,730**	**83**	**64,800**	**73**	**1,083,600**	**122**
Profit /Loss								
Profit (loss) before Tax	333,275	49	(6,443)	(18)	21,555	24	738,440	83
Tax (30%)	99,983	15	0	0	6,466	7	221,532	25
Profit (loss) after Tax	233,293	34	(6,443)	(18)	15,088	17	516,908	58

Table 66 Abuja Mechanical Emptier – Income Statement using 5% VAT

Abuja	Company A		Company B		Company C		Company E	
Item	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)
Personnel Costs								
Wages paid:								
Permanent staff	24,000	3	7,680	21	12,960	15	267,480	30
Commission Paid	23,400	3	0	0	0	0	0	0
Dump Site Security	0	0	0	0	0	0	0	0

Police commission	0	0	0	0	0	0	0	0
Social Contribution to permanent staff	0	0	0	0	0	0	0	0
Medical expenses	0	0	400	1	0	0	467	0
Subtotal	**47,400**	**7**	**8,080**	**22**	**12,960**	**15**	**267,947**	**30**
Operating and dumping costs								
Registration fees of company	467	0	667	2	667	1	500	0
Licensing fees for truck	2,333	0	333	1	467	1	233	0
Office building rent	6,667	1	1,000	3	0	0	0	0
Telephone	2,400	0	0	0	800	1	1,600	0
Electricity	0	0	100	0	0	0	0	0
Water	0	0	0	0	0	0	0	0
Offices supplies, computer	0	0	0	0	0	0	0	0
Truck Maintenance / Repairs	4,800	1	0	0	4,000	5	6,800	1
Truck servicing	8,000	1	533	1	667	1	1,600	0
Pump servicing	2,400	0	533	1	0	0	0	0
Safety Equipment	320	0	667	2	400	0	0	0
Fuel (pumping & transport)	55,440	8	8,580	24	12,835	14	39,600	4
Sludge dumping/tipping Fees	0	0	0	0	0	0	0	0
Dump Site Maintenance	0	0	0	0	0	0	0	0
Steam Cleaning	0	0	0	0	0	0	0	0
Tires	11,667	2	2,080	6	217	0	2,880	0
Suction pipes	267	0	267	1	300	0	0	0
Radio Advertising	3,200	0	2,000	6	0	0	0	0
Subtotal	**97,960**	**14**	**16,760**	**47**	**20,352**	**23**	**53,213**	**6**
Equipment Capital costs								
Loan Interest paid to Bank	6,531	1	0	0	0	0	0	0
Insurance costs for trucks, vehicles	3,833	1	0	0	1,200	1	0	0
If used, costs to refurbish truck (one time- upfront)	0	0	2,667	7	1,667	2	0	0
Truck Depreciation	40,000	6	8,667	24	7,067	8	24,000	3

Cost								
Tires annual depreciation Cost	0	0	0	0	0	0	0	0
Suction pipes depreciation Cost	0	0	0	0	0	0	0	0
Office equipment depreciation costs	0	0	0	0	0	0	0	0
Vehicle rental cost	0	0	0	0	0	0	0	0
Subtotal	**50,365**	**7**	**11,333**	**31**	**9,933**	**11**	**24,000**	**3**
Revenue Sources								
Emptying (Households only)	384,000	56	12,480	35	48,000	54	768,000	86
Emptying (Hospitals)	9,600	1	1,040	3	0	0	0	0
Emptying (Religious Centres)	64,000	9	2,080	6	0	0	168,000	19
Emptying (Public toilets)	0	0	6,400	18		0	10,800	1
Emptying (Schools)	28,800	4	1,040	3	6,000	7	100,800	11
Emptying (Companies)	40,800	6	3,120	9	6,000	7	36,000	4
Emptying (Eateries))	0	0	3,120	9	4,800	5	0	0
Leasing of truck to AEPB	1,800	0	450	1	0	0	0	0
If sold for re-use: Income from sale to buyer	0	0	0	0	0	0	0	0
Subtotal	**529,000**	**77**	**29,730**	**83**	**64,800**	**73**	**1,083,600**	**122**
Profit /Loss								
Profit (loss) before Tax	333,275	49	(6,443)	(18)	21,555	24	738,440	83
Tax (VAT 5%)	26,450	4	0	0	3,240	4	54,180	6
Profit (loss) after Tax	306,825	45	(6,443)	(18)	18,315	21	684,260	77

Table 67 shows the weighted average income statement for Companies “A”, “C” and “E”, all medium size businesses between 2 to 5 trucks. The weight was based on the annual number of trips made by each company. It is important to highlight that the average is skewed towards Company “E” the largest of the medium size businesses. Table 66 shows comparative income statements for each of these companies. Abuja only has one small business with one truck, Company “B”, and the income statement is shown in Table 66 above.

Table 67 Abuja: Average Income Statement for Medium Size Businesses

Abuja	
Item	**Annual Amt (USD)**
Personnel Costs	
Wages paid:	
Permanent staff	153,653
Commission Paid	9,636
Dump Site Security	0
Police commission	0
Social Contribution to permanent staff	0
Medical expenses	250
Subtotal	**163,539**
Operating and dumping costs	
Registration fees of company	495
Licensing fees for truck	1,111
Office building rent	2,745
Telephone	1,887
Electricity	0
Water	0
Offices supplies, computer	0
Truck Maintenance / Repairs	5,827
Truck servicing	4,186
Pump servicing	988
Safety Equipment	153

Fuel (pumping & transport)	44,697
Sludge dumping/tipping Fees	0
Dump Site Maintenance	0
Steam Cleaning	0
Tires	6,357
Suction pipes	126
Radio Advertising	1,318
Subtotal	**69,890**
Equipment Capital costs	
Loan Interest paid to Bank	2,690
Insurance costs for trucks, vehicles	1,643
If used, costs to refurbish truck (one time- upfront)	89
Truck Depreciation Cost	29,687
Tires annual depreciation Cost	0
Suction pipes depreciation Cost	0
Office equipment depreciation costs	0
Vehicle rental cost	0
Subtotal	**34,108**
Revenue Sources	
Emptying (Households only)	571,508
Emptying (Hospitals)	3,953
Emptying (Religious Centres)	116,222
Emptying (Public toilets)	5,777
Emptying (Schools)	66,099
Emptying (Companies)	36,378
Emptying (Eateries))	256
Leasing of truck to AEPB	741
If sold for re-use: Income from sale to buyer	0
Subtotal	**800,934**
Profit /Loss	
Profit (loss) before Tax	**533,398**
Tax	**160,019**

Profit (loss) after Tax	**373,378**

Ibadan

Companies "A", "B" and "C" all are profitable on a USD basis. The unit profit margin ranged from a low of 10 USD / trip for Company "C" to a high of 34 USD / trip for Company "B". The wide gap between unit profit margins was driven primarily by equipment and maintenance costs. In addition, Company "C"'s three trucks had the largest holding capacity, one 10.5m^3 truck and two 12m^3 trucks compared with Company "B"'s trucks which had holding capacities of 6m^3 each. Both Company "B" and "C" charge similar rates per trip. This implies for every two trips per household made by Company "B", Company "C" only made one trip. This then translates to lower revenues for company "C" for the same household. Company "C"'s operations and maintenance costs were at least 17 USD /per trip and 31 USD / trip higher than Company "A" and Company "B". Company "B" had the lowest maintenance and capital costs of all three operators. It could be inferred that Company "B" is the most experienced of the operators. Company "B" started the business 19 years ago and runs this as his primary business. For the first 11 years of the business, Company "B" leased sewage tank trucks from government agencies (the Ministry of Works and Housing and the Nigerian Prisons Service).

Table 68 Ibadan Company Operational Data

Ibadan	Company A	Company B	Company C
Exchange rate 1USD – NGN	150	150	150
Average total # of trips / year	2,078	3,118	1,511
Average total # of trips / month	173	260	126
Average # of Household trips / year	0	960	1,439
Average # of Household trips / month	0	80	120
Average tariff (USD)	70	77	84
Average truck fleet capacity (m^3)	9	6	12
Truck depreciation rate	5	5	5

# of trucks	2	3	3
Operation days / week	5	6	3

Table 69 Ibadan Mechanical Emptiers – Income Statement using 30% tax rate

Ibadan	Company A		Company B		Company C	
Item	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)
Personnel Costs						
Wages paid:						
Permanent staff	14,640	7	18,160	6	10,800	7
Commission Paid	1,600	1	4,788	2	2,598	2
Dump Site Security	533	0	533	0	533	0
Police commission	533	0	533	0	533	0
Social Contribution to permanent staff	0	0	0	0	0	0
Medical expenses	0	0	0	0	1,040	1
Subtotal	**17,307**		**24,015**		**15,505**	
Operating and dumping costs						
Registration fees of company	140	0	140	0	140	0
Licensing fees for truck	240	0	360	0	300	0
Office building rent	1,200	1	640	0	400	0
Telephone	800	0	0	0	0	0
Electricity	240	0	56	0	200	0
Water	0	0	0	0	0	0
Offices supplies, computer	0	0	0	0	80	0
Trucks Maintenance and repair	16,000	8	4,800	2	25,120	17
Truck servicing	960	0	4,640	1	9,600	6
Pump servicing	3,200	2	2,400	1	0	0
Safety Equipment	500	0	800	0	72	0
Fuel (pumping & transport)	26,000	13	31,176	10	16,616	11

Sludge dumping/tipping Fees	0	0	0	0	0	0
Dump Site Maintenance	3,333	2	3,333	1	3,679	2
Steam Cleaning	80	0	0	0	0	0
Tires	10,720	5	4,400	1	15,187	10
Suction pipes	282	0	423	0	200	0
Others (specify)	0	0	0	0	360	0
Subtotal	**63,696**	**31**	**53,169**	**17**	**71,955**	**48**
Equipment Capital costs						
Loan Interest paid to Bank	0	0	0	0	0	0
Insurance costs for trucks, vehicles	2,000	1	20	0	300	0
If used, costs to refurbish truck (one time- upfront)	0	0	1,271	0	0	0
Truck Depreciation Cost	13,333	6	8,000	3	18,000	12
Tires annual depreciation Cost	0	0	0	0	0	0
Suction pipes depreciation Cost	0	0	0	0	0	0
Office equipment depreciation costs	0	0	0	0	0	0
Vehicle rental cost	0	0	0	0	0	0
Subtotal	**15,333**	**7**	**9,291**	**3**	**18,300**	**12**
Revenue Sources						
Emptying (Households only)	0	0	96,000	31	119,880	79
Emptying (Industrial)	145,488	70	143,840	46	7,200	5
Other uses** of the trucks (specify each)	0	0	0	0	0	0
If sold for re-use: Income from sale to buyer	0	0	0	0	0	0
Subtotal	**145,488**	**70**	**239,840**	**77**	**127,080**	**84**
Profit /Loss						
Profit (loss) before Tax	**49,152**	24	**153,366**	49	**21,321**	14
Tax (30%)	**14,746**	7	**46,010**	15	**6,396**	4
Profit (loss) after Tax	**34,407**	17	**107,356**	34	**14,925**	10

Table 70 Ibadan Mechanical Emptiers Income Statement using 5% tax rate

Ibadan	Company A		Company B		Company C	
Item	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)
Personnel Costs						
Wages paid:						
Permanent staff	14,640	7	18,160	6	10,800	7
Commission Paid	1,600	1	4,788	2	2,598	2
Dump Site Security	533	0	533	0	533	0
Police commission	533	0	533	0	533	0
Social Contribution to permanent staff	0	0	0	0	0	0
Medical expenses	0	0	0	0	1,040	1
Subtotal	**17,307**		**24,015**		**15,505**	
Operating and dumping costs						
Registration fees of company	140	0	140	0	140	0
Licensing fees for truck	240	0	360	0	300	0
Office building rent	1,200	1	640	0	400	0
Telephone	800	0	0	0	0	0
Electricity	240	0	56	0	200	0
Water	0	0	0	0	0	0
Offices supplies, computer	0	0	0	0	80	0
Trucks Maintenance and repair	16,000	8	4,800	2	25,120	17
Truck servicing	960	0	4,640	1	9,600	6
Pump servicing	3,200	2	2,400	1	0	0
Safety Equipment	500	0	800	0	72	0
Fuel (pumping & transport)	26,000	13	31,176	10	16,616	11
Sludge dumping/tipping Fees	0	0	0	0	0	0

Dump Site Maintenance	3,333	2	3,333	1	3,679	2
Steam Cleaning	80	0	0	0	0	0
Tires	10,720	5	4,400	1	15,187	10
Suction pipes	282	0	423	0	200	0
Others (specify)	0	0	0	0	360	0
Subtotal	**63,696**	**31**	**53,169**	**17**	**71,955**	**48**
Equipment Capital costs						
Loan Interest paid to Bank	0	0	0	0	0	0
Insurance costs for trucks, vehicles	2,000	1	20	0	300	0
If used, costs to refurbish truck (one time- upfront)	0	0	1,271	0	0	0
Truck Depreciation Cost	13,333	6	8,000	3	18,000	12
Tires annual depreciation Cost	0	0	0	0	0	0
Suction pipes depreciation Cost	0	0	0	0	0	0
Office equipment depreciation costs	0	0	0	0	0	0
Vehicle rental cost	0	0	0	0	0	0
Subtotal	**15,333**	**7**	**9,291**	**3**	**18,300**	**12**
Revenue Sources						
Emptying (Households only)	0	0	96,000	31	119,880	79
Emptying (Industrial)	145,488	70	143,840	46	7,200	5
Other uses** of the trucks (specify each)	0	0	0	0	0	0
If sold for re-use: Income from sale to buyer	0	0	0	0	0	0
Subtotal	**145,488**	**70**	**239,840**	**77**	**127,080**	**84**
Profit /Loss						
Profit (loss) before Tax	**49,152**	24	**153,502**	49	**21,321**	14
Tax (VAT 5%)	**7,274**	4	**12,000**	4	**6,354**	4
Profit (loss) after Tax	**41,878**	20	**141,502**	45	**14,967**	10

The registered emptying businesses interviewed are medium size with each operator having between 2 and 5 trucks. Table 70 illustrates a weighted average income statement for the 3 companies operating in Ibadan. Company "C" as mentioned in previous sections had pulled out of the business but was included in the average nonetheless.

Table 71 Ibadan: Average Income Statement for Medium Size Businesses

Ibadan	Medium Size Business (2 - 5 trucks)
Item	Annual Amt (USD)
Personnel Costs	
Wages paid:	
Permanent staff	15,411
Commission Paid	3,307
Dump Site Security	533
Police commission	533
Social Contribution to permanent staff	0
Medical expenses	234
Subtotal	**20,019**
Operating and dumping costs	
Registration fees of company	140
Licensing fees for truck	309
Office building rent	759
Telephone	248
Electricity	145
Water	0
Offices supplies, computer	18
Trucks Maintenance and repair	12,848
Truck servicing	4,617
Pump servicing	2,107
Safety Equipment	543
Fuel (pumping & transport)	26,292

Sludge dumping/tipping Fees	0
Dump Site Maintenance	3,411
Steam Cleaning	25
Tires	8,788
Suction pipes	329
Others (specify)	81
Subtotal	**60,662**
Equipment Capital costs	
Loan Interest paid to Bank	0
Insurance costs for trucks, vehicles	697
If used, costs to refurbish truck (one time- upfront)	591
Truck Depreciation Cost	11,905
Tires annual depreciation Cost	0
Suction pipes depreciation Cost	0
Office equipment depreciation costs	0
Vehical rental cost	0
Subtotal	**13,193**
Revenue Sources	
Emptying (Households only)	71,637
Emptying (Industrial)	113,567
Other uses** of the trucks (specify each)	0
If sold for re-use: Income from sale to buyer	0
Subtotal	**185,204**
Profit /Loss	
Profit (loss) before Tax	**91,330**
Tax	**27,399**
Profit (loss) after Tax	**63,931**

Yenagoa

In Yenagoa, all companies ("A", "C" and "D") are not profitable on a USD basis except for company "B". The profit (loss) margin ranged from -266 USD / trip to 19 USD / trip. The losses can be explained by the low number of trips undertaken during the year by each of the operators. The number of trips could not offset the high equipment and maintenance costs incurred by each of the operators running losses. The Yenagoa market, although small, is not saturated based on the current number of known service providers (see Table 59). It is estimated that approximately 13,900 septic tanks need to be evacuated annually in Yenagoa. The mechanical operators currently provide only 5% of the required services based on the trip information provided during the interviews. This implies that either majority of the tanks are being discharged directly into nearby water channels by the households or there are service providers coming in from outside the city to provide the services or the trips reported by the interviewed emptiers are understated or the households are simply not evacuating. It is entirely possible that the operators really do not know how many trips they had really undertaken since most of the operators did not keep logs of their customers or the trips they had taken. Most of the data obtained on the number of trips was as a result of asking the operators indirect questions thus leading to an estimate of the number of trips they had taken over a period of months.

Table 72 Yenagoa Company Operational Data

Yenagoa	Company A	Company B	Company C	Company D
Exchange rate 1USD - NGN	150	150	150	150
Average total # of trips / year	55	504	44	156
Average total # of trips / month	5	42	4	13
Average # of household trips / year	27	360	36	72
Average # of household trips / month	2	30	3	6
Average tariff rate (USD)	102	94	100	90
Average truck fleet capacity (m^3)	12	10	8	7

Truck depreciation rate	5	5	5	5
# of trucks	2	1	1	1
Operation days / week	7	7	7	7

Table 73 Yenagoa Mechanical Emptiers Income Statement using 30% tax rate

Item	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)	Annual Amt (USD)	Amt / Trip (USD)
Personnel Costs								
Wages paid:								
Permanent staff	1,200	22	5,600	11	1,200	27	6,000	38
Commission Paid	0	0	0	0	0	0	0	0
Dump Site Security	0	0	0	0	0	0	0	0
Police commission	0	0	0	0	0	0	0	0
Social Contribution to permanent staff	0	0	0	0	400	9	0	0
Medical expenses	0	0	0	0	0	0	0	0
Subtotal	**1,200**	**22**	**5,600**	**11**	**1,600**	**36**	**6,000**	**38**
Operating and dumping costs								
Registration fees of company	787	14	767	2	800	18	507	3
Licensing fees for truck	113	2	267	1	133	3	0	0
Office building rent	0	0	960	2	0	0	0	0
Telephone	0	0	0	0	0	0	0	0
Electricity	0	0	0	0	0	0	0	0
Water	0	0	0	0	0	0	0	0
Offices supplies, computer	0	0	0	0	0	0	0	0
Truck Maintenance / Repairs	0	0	0	0	867	20	2,400	15
Truck servicing	1,200	22	2,400	5	2,240	51	1,600	10
Pump servicing	0	0	0	0	0	0	0	0
Safety Equipment	0	0	0	0	0	0	40	0
Fuel (pumping &	565	10	12,600	25	1,100	25	4,680	30

transport)								
Sludge dumping/tipping Fees	800	15	1,000	2	800	18	800	5
Dump Site Maintenance	0	0	0	0	0	0	0	0
Steam Cleaning	0	0	480	1	0	0	0	0
Tires	1,400	26	2,200	4	2,000	45	2,400	15
Suction pipes	360	7	667	1	178	4	0	0
Radio Advertising	0	0	0	0	0	0	0	0
Subtotal	**5,225**	**96**	**21,340**	**42**	**8,118**	**184**	**12,427**	**80**
Equipment Capital costs								
Loan Interest paid to Bank	0	0	0	0	0	0	0	0
Insurance costs for trucks, vehicles	0	0	0	0	0	0	0	0
If used, costs to refurbish truck (one time- upfront)	11,333	207	0	0	5,067	115	333	2
Truck Depreciation Cost	1,667	30	6,667	13	1,333	30	2,667	17
Tires annual depreciation Cost	0	0	0	0	0	0	0	0
Suction pipes depreciation Cost	0	0	0	0	0	0	0	0
Office equipment depreciation costs	0	0	0	0	0	0	0	0
Vehicle rental cost	0	0	0	0	0	0	0	0
Subtotal	**13,000**	**238**	**6,667**	**13**	**6,400**	**145**	**3,000**	**19**
Revenue Sources								
Emptying (Households only)	2,667	49	36,000	71	3,600	82	7,200	46
Emptying (Hospitals)	800	15	0	0	0	0	0	0
Emptying (Religious Centres)	133	2	0	0	200	5	0	0
Emptying (Public toilets)	267	5	0	0	0	0	1,920	12
Emptying (Schools)	0	0	0	0	200	5	960	6
Emptying (Companies)	0	0	0	0	0	0	2,400	15
Emptying (Eateries))	133	2	11,520	23	400	9	1,600	10
Leasing of truck to AEPB	1,600	29	0	0	0	0	0	0

If sold for re-use: Income from sale to buyer	0	0	0	0	0	0	0	0
Subtotal	**5,600**	**102**	**47,520**	**94**	**4,400**	**100**	**14,080**	**90**
Profit /Loss								
Profit (loss) before Tax	(13,825)	(253)	13,913	28	(11,718)	(266)	(7,347)	(47)
Tax	0	0	4,174	8	0	0	0	0
Profit (loss) after Tax	**(13,825)**	**(253)**	**9,739**	**19**	**(11,718)**	**(266)**	**(7,347)**	**(47)**

The mechanical emptying businesses interviewed In Yenagoa are small size with each operator having between 1 truck. Company "A" bought a second truck recently but has not yet been put into operation. Table 74 illustrates an average income statement for the 4 companies operating in Yenagoa.

Table 74 Yenagoa: Weighted Average Income Statement for Small Size Businesses

Yenagoa	Small Size Business (1 truck)
Item	Annual Amt (USD)
Personnel Costs	
Wages paid:	
Permanent staff	5,110
Commission Paid	0
Dump Site Security	0
Police commission	0
Social Contribution to permanent staff	23
Medical expenses	0
Subtotal	**5,133**
Operating and dumping costs	
Registration fees of company	717
Licensing fees for truck	193

Office building rent	638
Telephone	0
Electricity	0
Water	0
Offices supplies, computer	0
Truck Maintenance / Repairs	544
Truck servicing	2,140
Pump servicing	0
Safety Equipment	8
Fuel (pumping & transport)	9,437
Sludge dumping/tipping Fees	933
Dump Site Maintenance	0
Steam Cleaning	319
Tires	2,172
Suction pipes	479
Radio Advertising	0
Subtotal	**17,579**
Equipment Capital costs	
Loan Interest paid to Bank	0
Insurance costs for trucks, vehicles	0
If used, costs to refurbish truck (one time- upfront)	1,179
Truck Depreciation Cost	5,175

Tires annual depreciation Cost	0
Suction pipes depreciation Cost	0
Office equipment depreciation costs	0
Vehicle rental cost	0
Subtotal	**6,354**
Revenue Sources	
Emptying (Households only)	25,797
Emptying (Hospitals)	58
Emptying (Religious Centres)	21
Emptying (Public toilets)	414
Emptying (Schools)	209
Emptying (Companies)	493
Emptying (Eateries))	8,015
Leasing of truck to AEPB	115
If sold for re-use: Income from sale to buyer	0
Subtotal	**35,123**
Profit /Loss	
Profit (loss) before Tax	**6,057**
Tax	**2,773**

Profit (loss) after Tax	**3,284**

3.4.4 Manual Emptiers

Majority of the manual emptying businesses in Ibadan are ad-hoc businesses. The service providers typically congregate in common areas and as requests for services are made, the business owner i.e. the person with the equipment recruits between 2 – 3 day laborers to assist with the job. The wages for daily laborers are fairly uniform for manual emptying. Each laborer is paid NGN 3,000 (USD 20) for the job and each job typically takes 2 days to complete. According to the manual emptiers, the amount charged per emptying varies according to the size of the pit or septic tank. The amount charged was also subject to the negotiating ability of the customer. Survey results show that 41.7% of households patronizing manual emptiers, paid between NGN 10,000 – NGN 15,000 (USD 66 – USD 100) on average for their facility to be emptied and the sludge disposed. The net income of the manual emptiers interviewed showed the following breakdown (Table 75 and 76).

Table 75 Ibadan: Manual Emptiers Income Breakdown

	Annual Net income (USD)					
	< 0	0 - 1,000	1,001 - 10,000	10,001 - 20,000	20,001 - 30,000	> 30,001
# of Manual Emptiers	7	1	6	2	1	2

Table 76 Ibadan: Average Income Statement for 19 Manual emptiers

Annual (USD)	**Average**
Revenue	25,255
Wages	10,607
Depreciation costs	208

Net income	**14,440**

In reality none of the manual emptiers end up going home making a loss. The negative income reflected above is due to the equipment depreciation charge. In addition the number of hired day laborers was kept constant in the above analysis. In reality the number could vary between 2- 4 depending on the size of the job.

In Yenagoa, the water table is quite high so pit latrines are not predominant (only 16% of the surveyed population had used manual emptiers). The manual emptying was done either by family members / community members (40%) or a manual emptier (60%). An interview was conducted with one manual emptier who was also a plumber and he works solo. This manual emptier leases a vacuum pump from a mobile water company which he uses to evacuate the pits. He leases the pump equipment for NGN 7,000 (USD 47) per day and charges customers NGN 15,000 (USD 100) to pump the supernatant only. If he is to evacuate the sludge he would charge up to NGN 50,000 for the complete service i.e. supernatant + fecal sludge evacuation. He also applies chemicals (alum, kerosene, "cabod" and petrol) to prepare the pits. The chemicals cost approximately NGN 2,500 (USD 17). For each job, the manual emptier could make anywhere between NGN 3,600 (USD 24) and NGN 40,000 (USD 267) per evacuation.

3.4.1.1.2 Breakeven Analysis

The breakeven analysis of various emptiers in the three cities is given in Tables 73 to 77.

Table 77 Abuja Break Even Analysis - 30% Corporate Tax

Abuja	Company A	Company B	Company C	Company E
Average total # of trips per year to break even	***2,526***	***485***	***519***	***851***
Average # of Household trips per year to break even	***1,766***	***194***	***421***	***550***

Table 78 Abuja Breakeven Analysis - 5% VAT

Abuja	Company A	Company B	Company C	Company E
Average total # of trips per year to break even	*2,832*	*469*	*524*	*1,017*
Average # of Household trips per year to break even	*768*	*253*	*356*	*374*

Table 79 Ibadan Breakeven Analysis - 30% corporate tax

Ibadan	Company A	Company B	Company C
Average total # of trips per year to break even	*1,382*	*827*	*1,223*
Average # of Household trips per year to break even	*0*	*254*	*1,151*

Table 80 Ibadan Breakeven Analysis - 5% VAT

Ibadan	Company A	Company B	Company C
Average total # of trips per year to break even	*1,455*	*880*	*1,292*
Average # of Household trips per year to break even	*0*	*271*	*1,220*

Table 81 Yenagoa Breakeven Analysis at 30% tax rate

Yenagoa	Company A	Company B	Company C	Company D

Average total # of trips per year to break even	***193***	***365***	***217***	***253***
Average # of Household trips per year to break even	***165***	***221***	***209***	***137***

3.4.1.1.3 IRR, NPV, Cash Flow and ROE

In reviewing the current city service delivery models (especially for the mechanized operators) it was determined that a primary route to profitability may involve making capital investments in purchasing a new vehicle fleet vs. buying a used fleet. Net Present Value (NPV) analysis of the truck investments was carried out based on specified assumptions. The IRR and ROE were also calculated for the debt and self-finance scenarios presented. The scenarios below are to determine the viability of the emptying businesses as stand-alone businesses. In most cases as mentioned in other sections of the report, the operators have other business ventures complementing the FS emptying business. It is also important to note that most of the operators (91%) self-financed their businesses due to the lack of access to finance. The debt scenario presented highlights the benefits / adverse impacts of leveraging debt to finance operations on cash flow, NPV and IRR at the current interest rate of 21% and a loan repayment period of 60 months (5 years). In reality the lenders may specify a shorter repayment period of 2 – 3 years.

Two scenarios are presented for Abuja mechanical operators in Tables 78 and 79. Table 78 assumes all the Emptiers self financed the purchase of their trucks while Table 79 assumes each emptier obtained financing from lending institutions to purchase their trucks. It is important to highlight that only Company “A“ had sought and received financing for 2 of its trucks. This was the basis for the debt assumptions in the model. The assumptions factored on a weighted basis what the equity requirements were. It is also important to highlight that the loan terms given by banks is typically a 2 – 3 year time repayment period.

The NPV in both the debt and no debt scenarios was positive for all companies except Company "B". While the ROE in both scenarios was positive across companies but much higher in the scenario where debt was assumed.

Table 82 Abuja: Financial Indicators for Mechanical Emptiers (no debt)

Assumes no debt[1]	Company A	Company B	Company C	Company E
FCF - Year 1 (USD)	18,883	(38,707)	(9,936)	391,817
FCF - Year 2 (USD)	243,571	8,468	30,299	564,328
FCF - Year 3 (USD)	270,588	9,729	33,833	622,006
FCF - Year 4 (USD)	300,166	11,083	37,693	685,369
FCF - Year 5 (USD)	332,563	12,540	41,914	754,983
NPV @ 15% Disc rate (USD)	822,795	(9,530)	90,742	2,235,168
After Tax IRR - 5 years	Nil	3%	315%	Nil
Pre-tax IRR - 5 years	Nil	4%	2672%	Nil
Average monthly cash to operator (USD)	19,430	52	2,230	50,308
Average ROE (5 year)	31%	1%	26%	42%

[1]*Company "A" did finance two of its trucks. All other businesses self financed.*

Table 83 Abuja: Financial Indicators for Mechanical Emptiers (with debt)

Assumes debt	Company A	Company B	Company C	Company E
FCF - Year 1 (USD)	93,409	(17,665)	6,989	446,708
FCF - Year 2 (USD)	260,027	6,791	28,950	559,953
FCF - Year 3 (USD)	289,850	8,286	32,672	618,243
FCF - Year 4 (USD)	322,082	9,817	36,675	682,067
FCF - Year 5 (USD)	(39,056)	(43,819)	(3,419)	607,959
NPV @ 15% Disc rate	728,130	(24,093)	79,028	2,197,176

(USD)				
After Tax IRR - 5 years	Nil	Nil	Nil	Nil
Pre-tax IRR - 5 years	Nil	Nil	Nil	Nil
Average monthly cash to operator (USD)	15,439	(610)	1,698	48,582
Average ROE (5 year)	45%	46%	30%	48%

Similarly, for the Ibadan mechanical operators, two scenarios are presented in Table 80 and Table 81. Table 80 assumes all the Emptiers self financed the purchase of their trucks while Table 81 assumes each emptier obtained financing from lending institutions to purchase their trucks. Company "A" as mentioned in earlier sections does not provide emptying services to households. The company focuses primarily on services to industrial clients. It is important to highlight that all the mechanical emptiers in Ibadan self financed the purchase of their trucks. It is also important to highlight that the loan terms given by banks is typically in a 2 – 3 year time repayment period.

The NPV for in both the debt and no debt scenarios was negative for Company "A". The NPV was negative for Company"C" in the debt scenario. In the no debt scenario all companies had positive average monthly cash flows. In the debt scenario, both Company A and Company C had negative monthly cash flows. While the ROE in both scenarios was positive across companies but much higher in the scenario where debt was assumed.

Table 84 Ibadan: Financial Indicators for Mechanical Emptiers (no debt)

Assumes no debt	Company A	Company B	Company C
FCF - Year 1 (USD)	(58,669)	14,355	(73,859)
FCF - Year 2 (USD)	11,280	62,538	21,667

FCF - Year 3 (USD)	14,846	70,113	27,683
FCF - Year 4 (USD)	18,721	78,417	34,238
FCF - Year 5 (USD)	22,937	87,522	41,385
NPV @ 15% Disc rate (USD)	(12,211)	223,352	12,088
After Tax IRR - 5 years	5%	Nil	22%
Pre-tax IRR - 5 years	7%	Nil	29%
Average monthly cash to operator (USD)	152	5,216	852
Average ROE (5 year)	2%	34%	8%

Table 85 Ibadan: Financial Indicators for Mechanical Emptiers (with debt)

Assumes debt	Company A	Company B	Company C
FCF - Year 1 (USD)	(28,175)	33,233	(32,691)
FCF - Year 2 (USD)	8,850	61,033	18,386
FCF - Year 3 (USD)	12,755	68,819	24,861
FCF - Year 4 (USD)	16,887	77,281	31,761
FCF - Year 5 (USD)	(58,742)	36,956	(68,884)
NPV @ 15% Disc rate (USD)	(33,318)	210,286	(16,406)
After Tax IRR - 5 years	Nil	Nil	Nil
Pre-tax IRR - 5 years	Nil	Nil	Nil
Average monthly cash to operator (USD)	(807)	4,622	(443)
Average ROE (5 year)	92%	46%	60%

Also, for the Yenagoa mechanical operators, two scenarios are presented in Table 82 and Table 83. Table 82 assumes all the Emptiers self financed the purchase of their trucks while Table 83 assumes each emptier obtained financing from lending institutions to purchase their trucks. It is important to highlight that all the mechanical emptiers in Ibadan self financed the purchase of their trucks.

Table 86 Yenagoa: Financial Indicators for Mechanical Emptiers (no debt)

Assumes no debt	Company A	Company B	Company C	Company D
FCF - Year 1 (USD)	(21,807)	(12,886)	(14,643)	(11,007)
FCF - Year 2 (USD)	(1,854)	23,043	(2,779)	3,136
FCF - Year 3 (USD)	(1,551)	25,875	(2,643)	3,651
FCF - Year 4 (USD)	(1,233)	28,967	(2,501)	4,208
FCF - Year 5 (USD)	(896)	32,345	(2,353)	4,811
NPV @ 15% Disc rate (USD)	(25,915)	64,257	(22,048)	(2)
After Tax IRR - 5 years	Nil	187%	Nil	15%
Pre-tax IRR - 5 years	Nil	443%	Nil	20%
Average monthly cash to operator (USD)	(456)	1,622	(415)	80
Average ROE (5 year)	-22%	24%	-46%	6%

Table 87 Yenagoa: Financial Indicators for Mechanical Emptiers (with debt)

Assumes debt	Company A	Company B	Company C	Company D
FCF - Year 1 (USD)	(12,811)	2,361	(9,276)	(4,756)
FCF - Year 2 (USD)	(2,571)	21,827	(3,207)	2,638
FCF - Year 3 (USD)	(2,168)	24,830	(3,011)	3,222
FCF - Year 4 (USD)	(1,774)	28,050	(2,824)	3,832

FCF - Year 5 (USD)	(24,991)	(8,494)	(16,729)	(11,934)
NPV @ 15% Disc rate (USD)	(32,141)	53,703	(25,763)	(4,329)
After Tax IRR - 5 years	Nil	Nil	Nil	Nil
Pre-tax IRR - 5 years	Nil	Nil	Nil	Nil
Average monthly cash to operator (USD)	(739)	1,143	(584)	(117)
Average ROE (5 year)	63%	26%	97%	329%

3.4.1.2 Sensitivity and risk analysis for:

Trucks: Number, age, capacity

Approximately 50% of the trucks in use have capacities of 6m^3 or less (see Figure x – Figure x. Businesses with larger capacity trucks are then at a pricing disadvantage since all three registered companies are currently charging comparable prices per trip. Since the demand for emptying services does not seem to price sensitive (e.g. in Ibadan, only 44% considered cost to be important as opposed to 56% who considered availability of services), the most logical option to increasing profit margins would be to charge 1.5 to 2 times the cost of a 6m^3 truck trip or look into downsizing the truck capacity in the fleet.

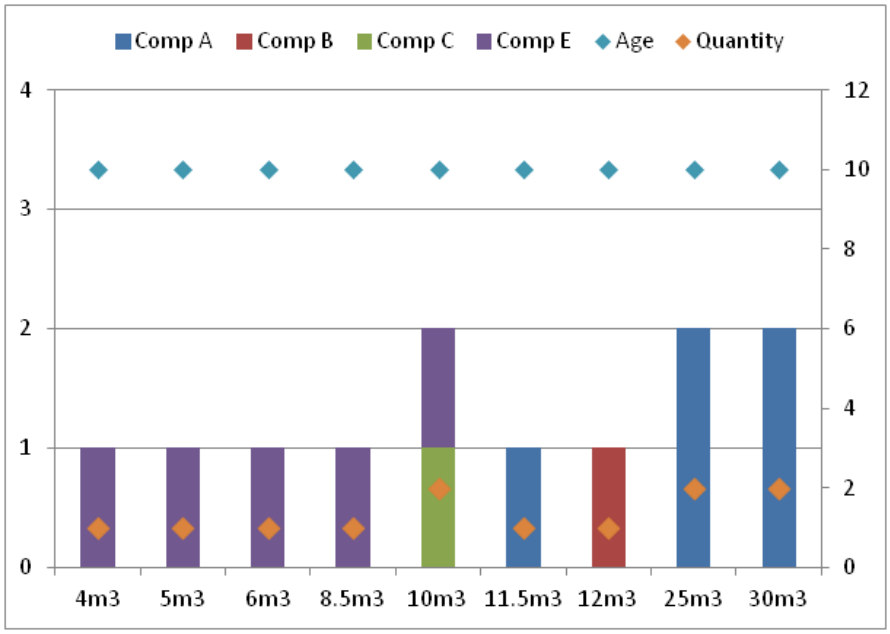


Figure 32 Truck Capacity, Age and Quantity (Abuja)

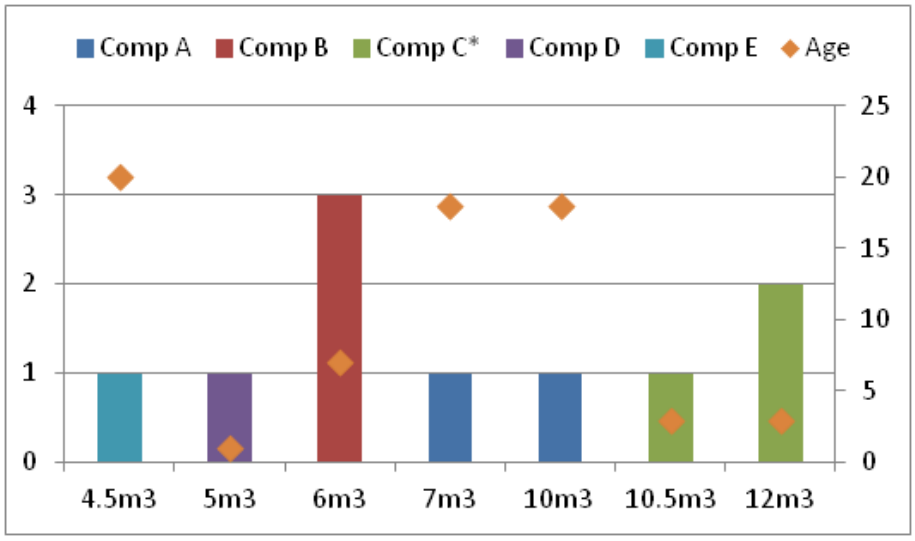


Figure 33 Truck Age, Capacity and Quantity (Ibadan)

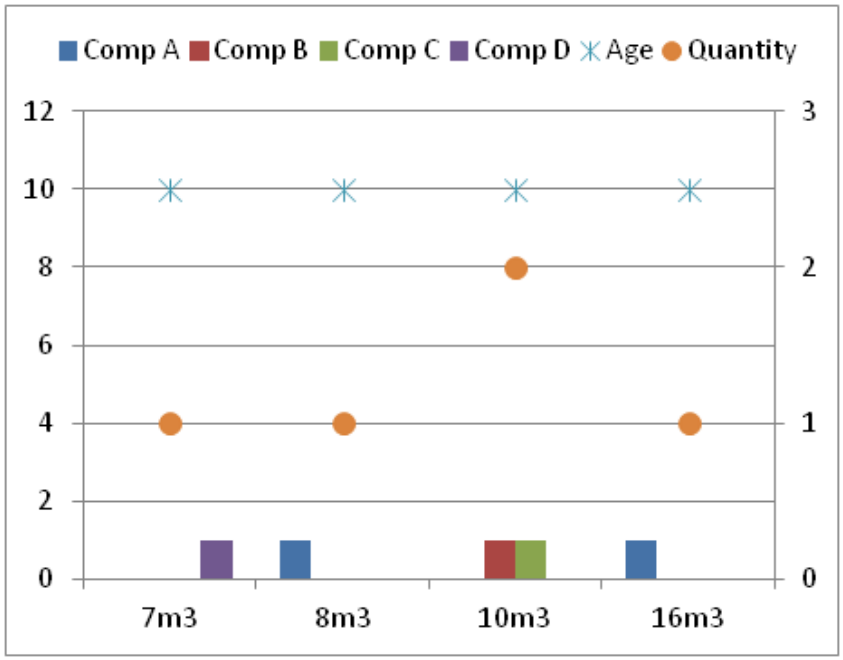


Figure 34 Truck Capacity, Age and Quantity (Yenagoa)

In all three cities, the mechanical emptiers charge customers per trip and not by the volume extracted. The public utility in Abuja, the AEPB charged per volume (USD 1.33/m^3) for household evacuations. The AEPB has 3 functional trucks. Based on Table 59, even if the AEPB's

3 trucks are included in the calculation, there is still a truck deficit of 57 in Abuja's daily service requirements. The tariff charged across cities does not vary much with truck capacity. The tariffs however can be negotiated and the emptier will take less than the normal charge after assessing the customer's ability to pay. However, the flat fee tariff charged by all of the operating companies puts the operators with larger capacity trucks at a pricing disadvantage. The emptying business could therefore generate more revenues for companies with smaller capacity trucks than with larger capacity trucks. The smaller capacity trucks will fill up much faster which in turn drives a higher number of trips or a higher emptying frequency for the household (Figure 37 and Tables 79 to 81).

Table 88 Abuja Mechanical Emptying Tariff

Abuja (Mechanical)	Company A	Company B	Company C	Company E
Average tariff (USD)	77	81	73	119
Average fleet truck capacity (m^3)	22	12	10	7

Table 89 Ibadan Mechanical Emptying Tariff

Ibadan	Company A	Company B	Company C
Average tariff (USD)	70	77	84
Average truck fleet capacity (m^3)	9	6	12

Table 90 Ibadan Mechanical Emptying Tariff

Yenagoa	Company A	Company B	Company C	Company D
Average tariff rate (USD)	102	94	100	90
Average truck fleet capacity (m^3)	12	10	8	7

Operations & Maintenance Costs

Abuja

In Abuja all of the trucks purchased by the Emptiers was used. None of the trucks were brand new. The trucks were foreign imports purchased through domestic dealers in Nigeria. Unfortunately, the age of the trucks prior to purchase in all cases was unknown. Based on the amounts being spent on maintenance of the vehicles it can be assumed that most of the purchased vehicles had been fully depreciated by the previous owners (i.e. utilised for 7+ years). The trucks all run on diesel and as the trucks age, they become less fuel efficient. None of the companies had replaced their fleet since original purchase (Figure 35). The cost of operating and maintaning (O&M) these used trucks is correspondingly high with approximately 80% of the O&M costs going to truck maintentance and fuel purchase (Figures 35 - 38).

Figure 35 Operations and Maintenance Costs - Company A (Abuja)

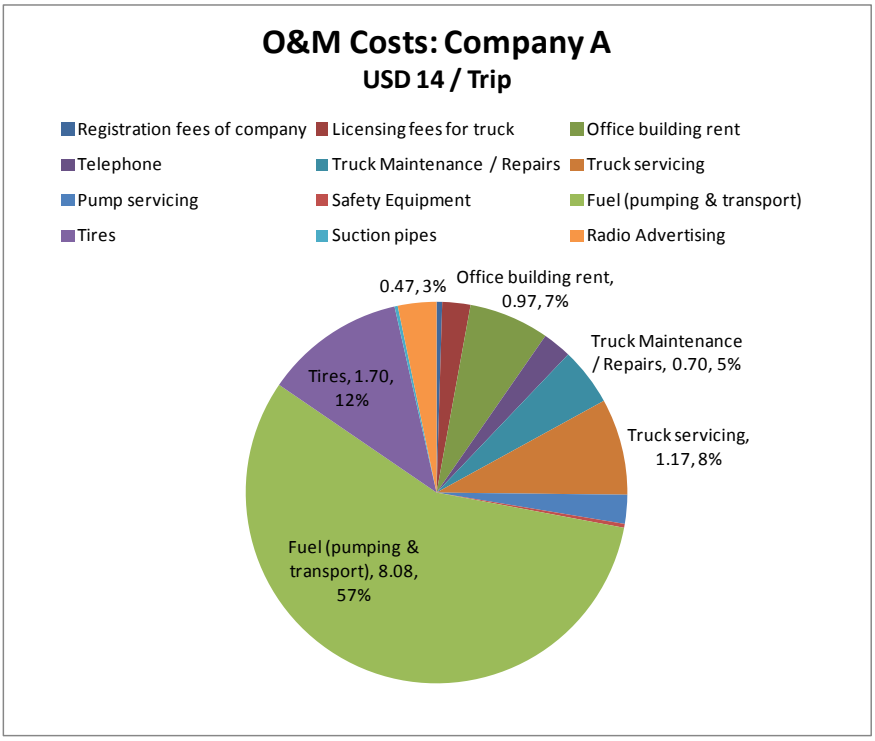


Figure 36 Operations and Maintenance Costs - Company B (Abuja)

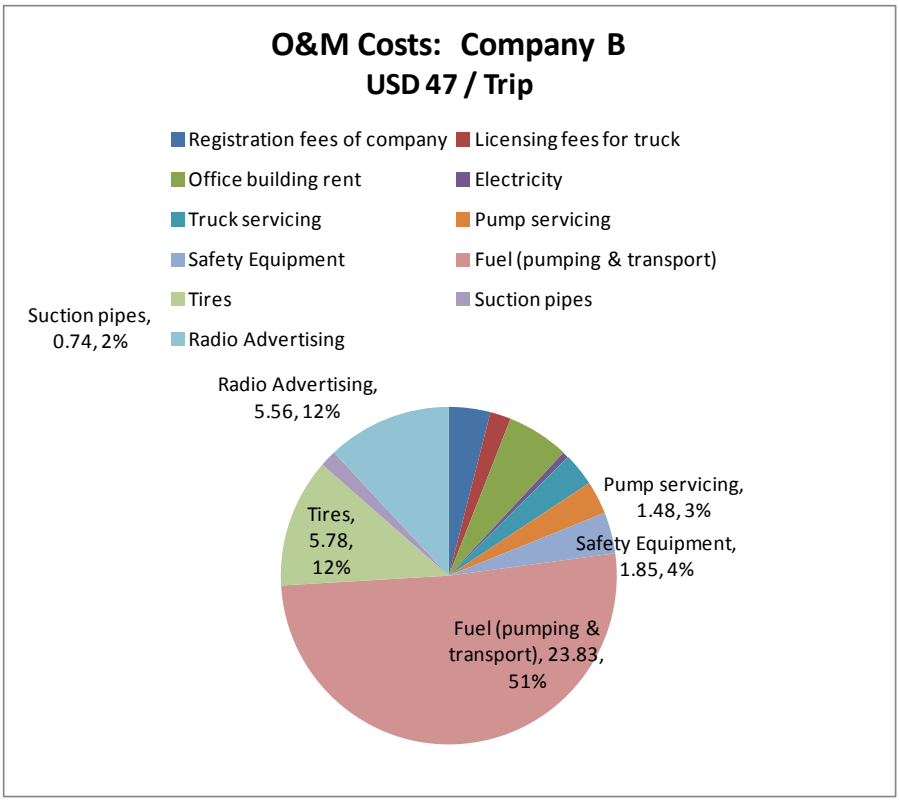


Figure 37 Operations and Maintenance Costs - Company C (Abuja)

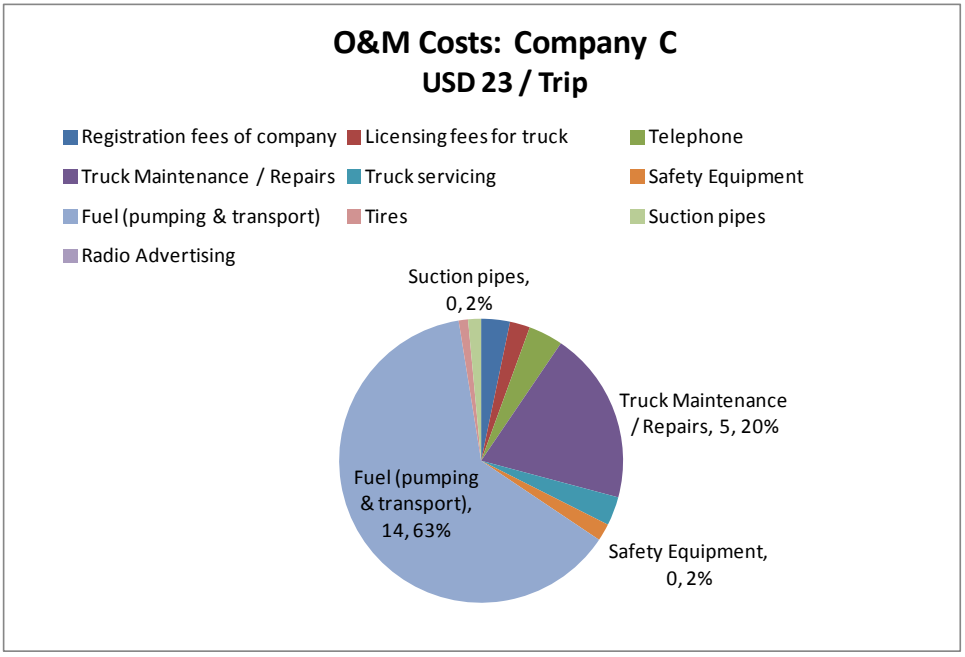
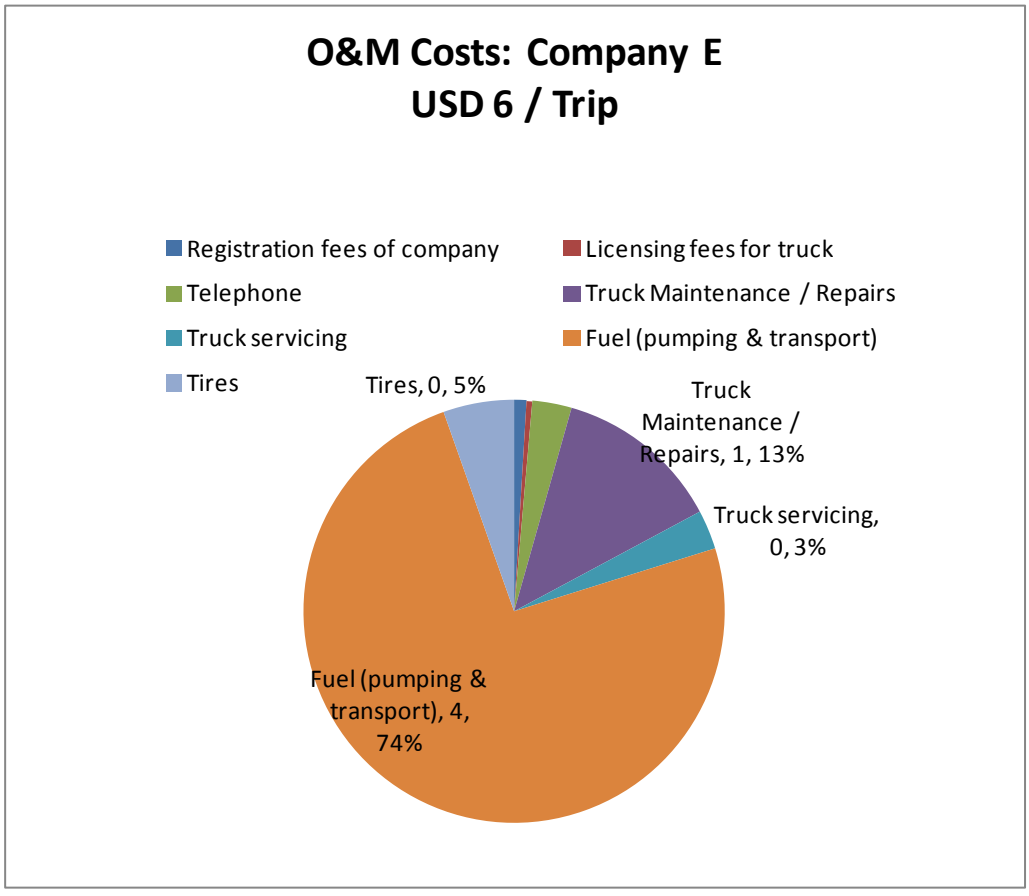


Figure 38 Operations and Maintenance Costs - Company E (Abuja)



Ibadan

Similar to the situation in Abuja, each of the trucks purchased by Companies A, B and C in Ibadan were previously used and the actual age unknown to the purchasers. All the trucks are foreign imports and were purchased through local dealers. Company B, however, purchased two of his four trucks from the Lagos State government.The most popular brand of used trucks is Mercedes Benz. The cost of purchasing brand new trucks was considered too cost prohibitive (in the range of 10 – 20 times the cost of a used truck). It is safe to assume that the imported used trucks had been fully depreciated overseas prior to being sold (i.e. utilised for 7+ years). The trucks all run on diesel and as the trucks age it can be assumed that the trucks have become less fuel efficient. None of the companies had replaced their fleet since original purchase (Figure 36). The cost of operating and maintaning (O&M) these used trucks is correspondingly high with over 80% of the O&M costs going to truck maintentance and fuel purchase (Figures 39 - 41).

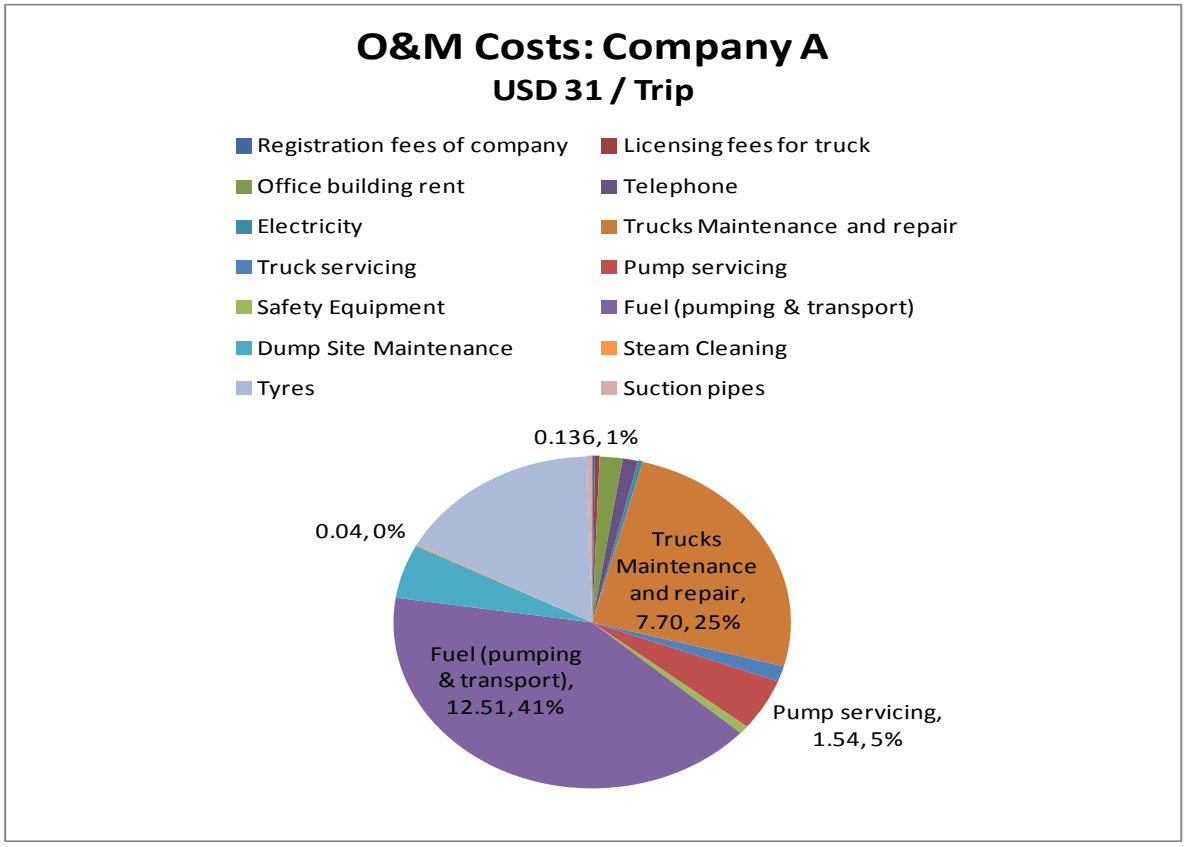


Figure 39 Operations and Maintenance Costs - Company A (Ibadan)

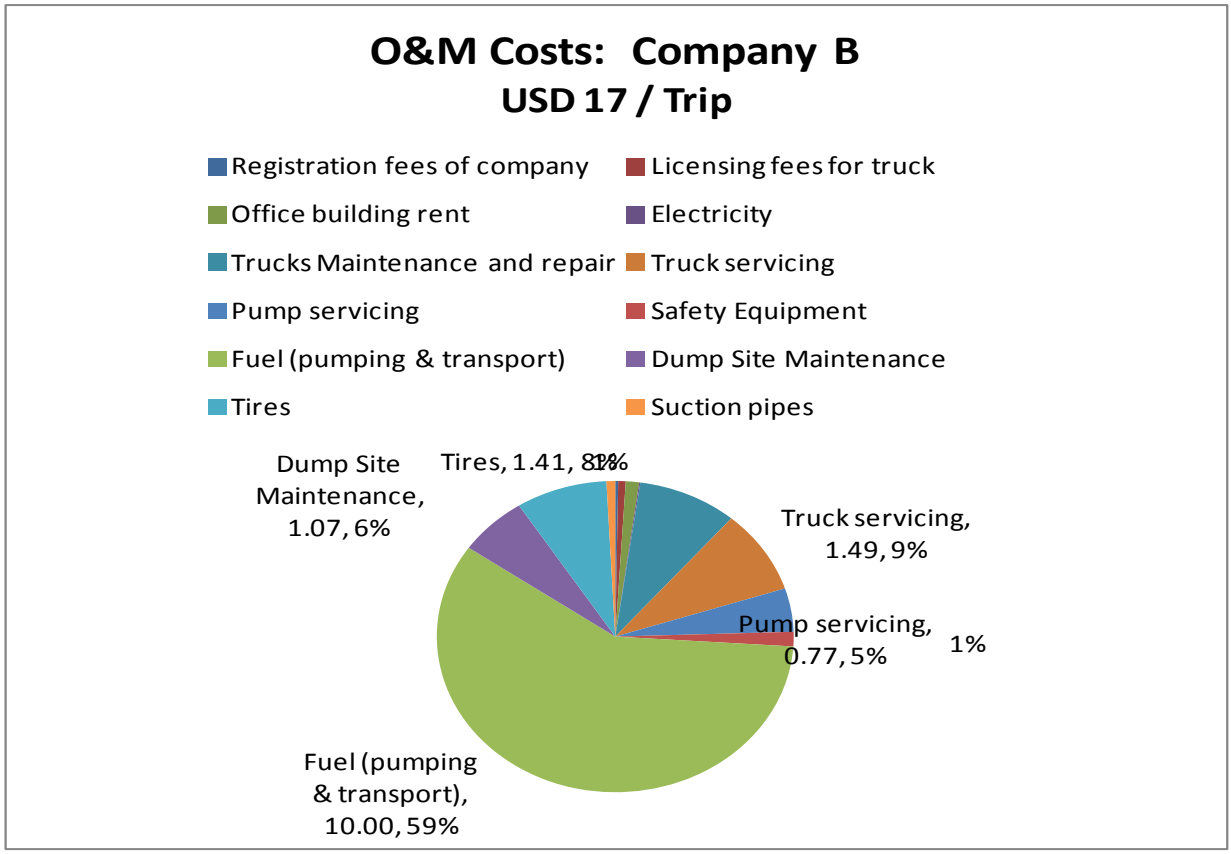


Figure 40 Operations and Maintenance Costs - Company B (Ibadan)

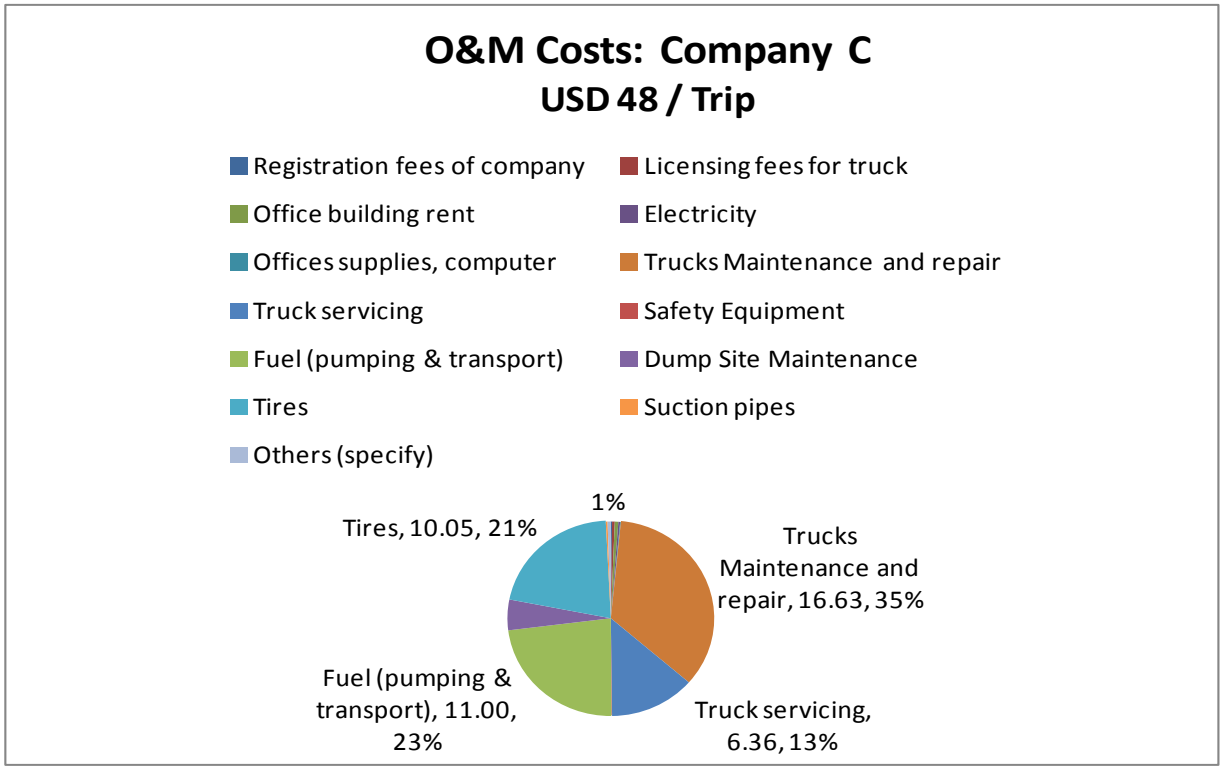


Figure 41 Operations and Maintenance Costs - Company C (Ibadan)

Yenagoa

The trucks in service in Yenagoa are all second hand purchases as well. The actual age unknown to the purchasers. All the trucks are foreign imports and were purchased through local dealers. Compared with the trucks in Abuja and Ibadan, majority of the Yenagoa trucks were older models and looked more like antique sewage trucks. At least 80% of the operators were mechanics and most of the O&M labour was handled in-house. The trucks all run on diesel and as the trucks age it can be assumed that the trucks have become less fuel efficient. None of the companies had replaced their fleet since original purchase (Figure 37). The cost of operating and maintaning (O&M) these used trucks is correspondingly high with over 80% of the O&M costs going to truck maintentance and fuel purchase (Figures 45 - 49). On a per unit basis, the O&M costs far exceeded that of counterpart operators in Abuja and Ibadan. The primary driver was the low number of trips taken by the Yenagoa operators.

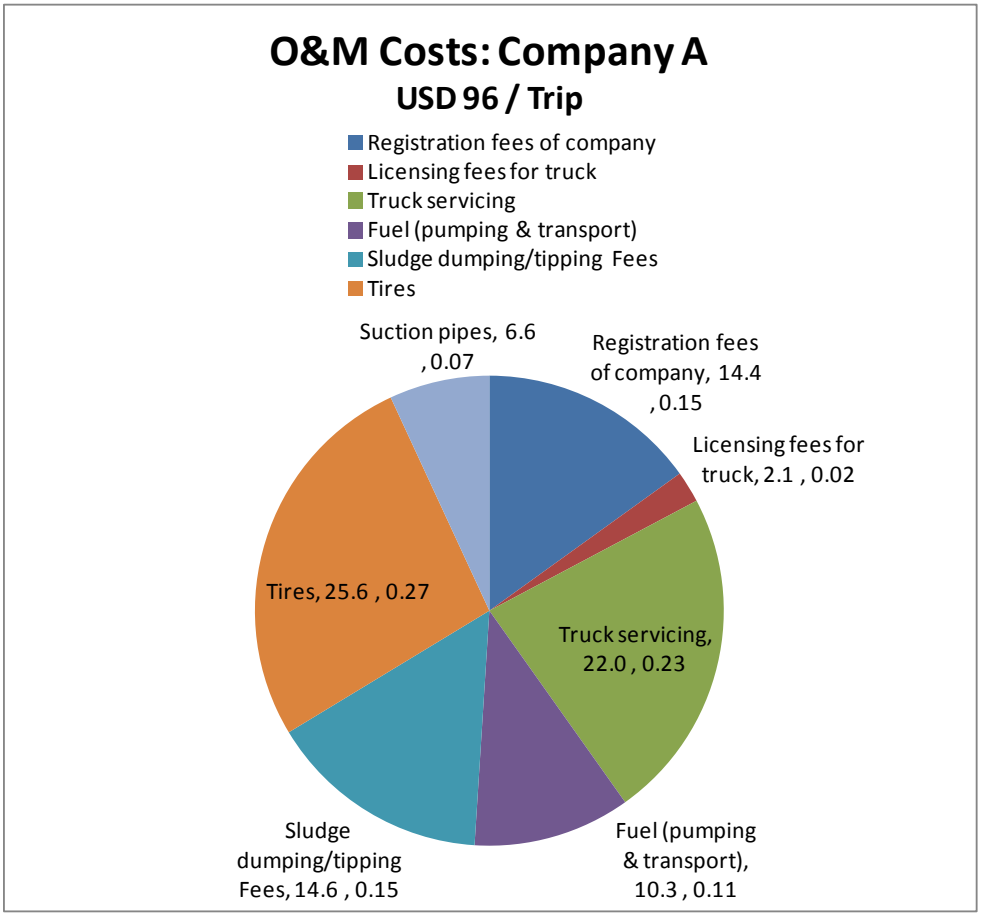


Figure 42 Operations and Maintenance Costs - Company A (Yenagoa)

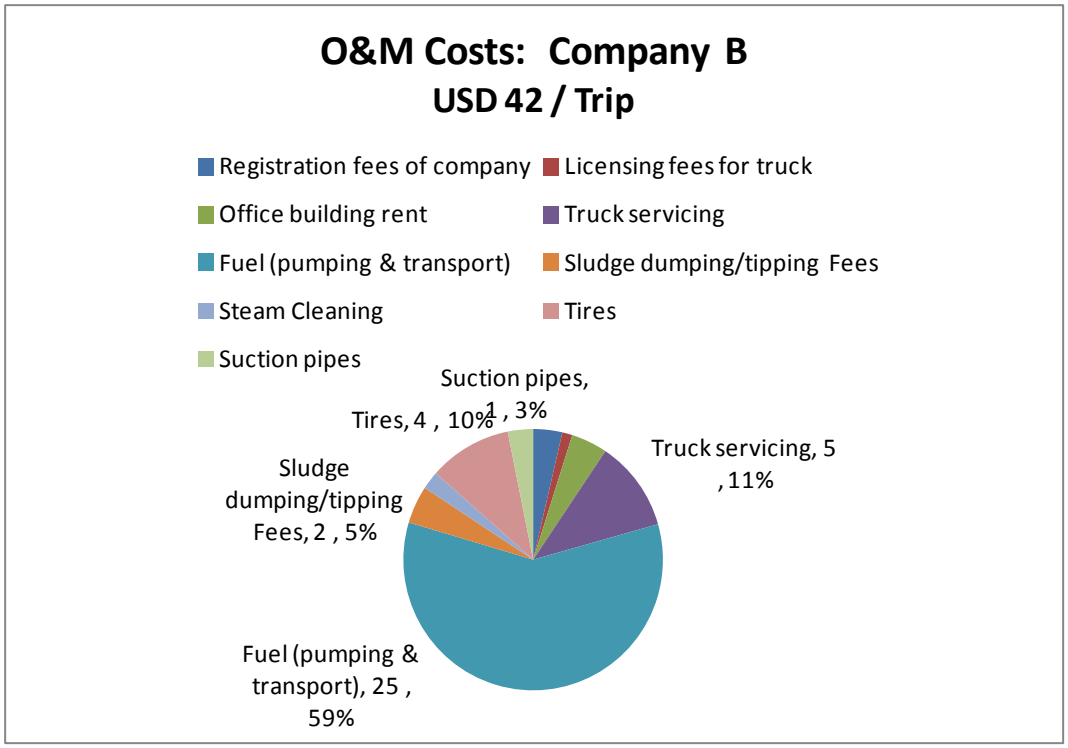


Figure 43 Operations and Maintenance Costs - Company B (Yenagoa)

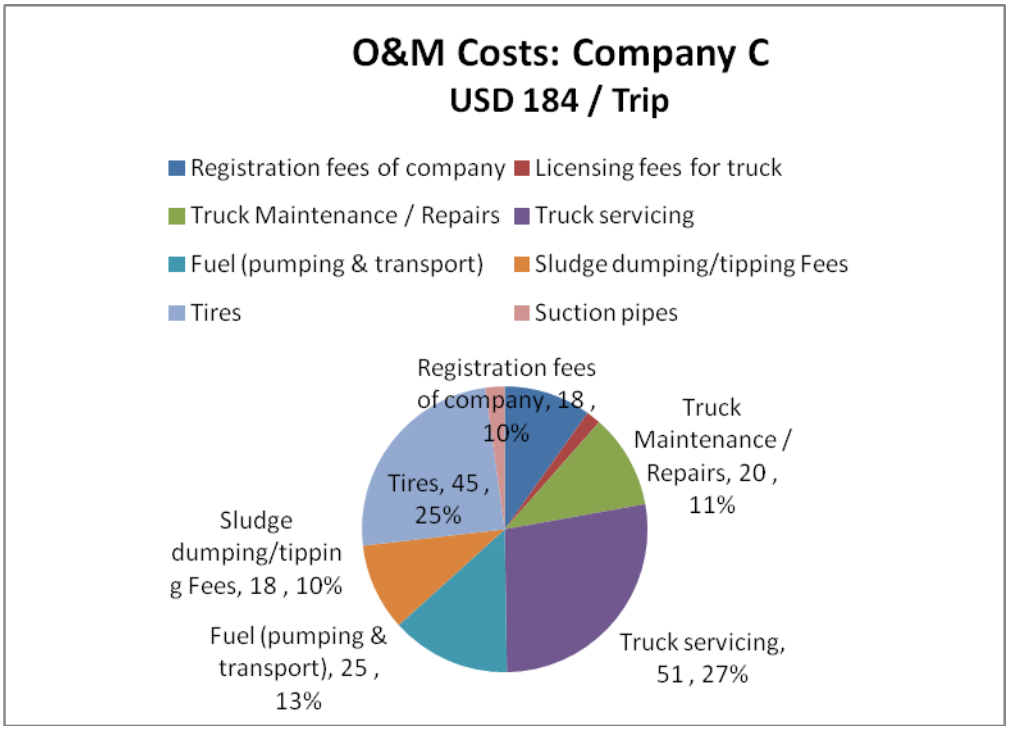


Figure 44 Operations and Maintenance Costs - Company C (Yenagoa)

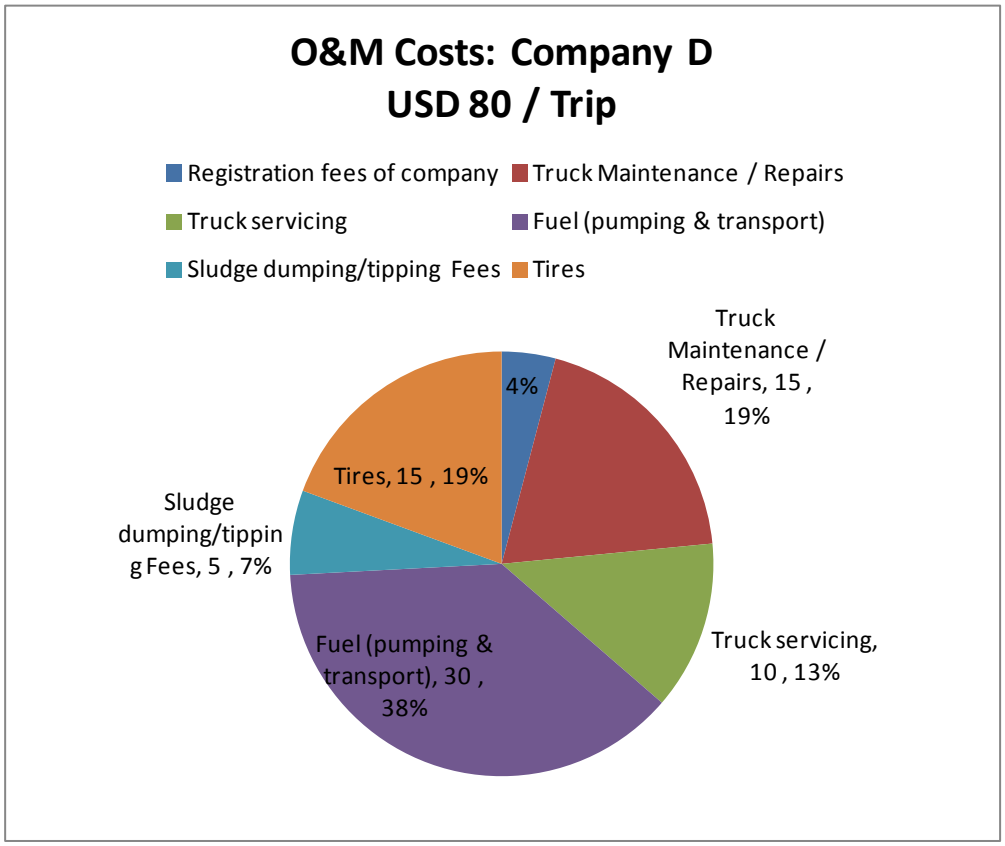


Figure 45 Operations and Maintenance Costs - Company D (Yenagoa)

In all 3 surveyed cities, over 80% of the O&M cost is allocated to the purchase of fuel and truck servicing / repairs. There are a few options to reducing the costs in each of these buckets.

- *Purchase a new fleet of trucks with extended warranty coverage from the manufacturer. Brand new trucks are less likely to require frequent repairs during the 1st five years of normal operations as compared to used trucks.*
- *Establish intermediate transfer stations within the city to reduce the distance travelled to the final disposal site.*
- *Purchase a fleet of new trucks that run on lower cost fuels. E.g. Compressed Natural Gas (CNG) which can also be produced using technology to recover methane from FS at the treatment facility.*

The operators pay an annual registration fee to the Ministry of Environment of NGN 2,100 (140 USD). The Ministry does not charge a dumping fee. However, the Ministry has passed on the responsibility of maintaining the site to the three registered operators. The dumpsite as confirmed by site observations and interviews with the Ministry, is not an adequately designed facility for FS treatment. According to the Ministry, the site was meant to be an experimental station with plans to design a state of the art FS treatment plant. The annual cost of rehabilitating the site, sity security, management of the oxidation ponds and drying beds is NGN1.5M (USD10,000). The cost is borne solely by the three registered operators which the Ministry has made a condition to providing evacuating and discharging services.

3.4.1.3 Access to Finance

Majority of the service provider companies did not consider approaching financial institutions to assist with financing truck purchases. Majority self-financed the purchase of their sewage trucks. The current conditions for accessing loans from financial institutions are quite onerous with interest rates as high as 22% and loan periods as short as 6 months. The interviews with stakeholders also revealed that financial institutions are not familiar with the business of FSM. Both the commercial and micro-finance banks interviewed were familiar with solid waste management and had provided asset financing for the purchase of trucks in this sector. The banks interviewed stressed that having a government guarantee for the loan is key to accessing funds. Alternatively, if the borrower has established contracts with customers then the bank is more likely to give consideration to the borrower's application.

In Abuja, only one mechanical operator (Company 'A') was successful in obtaining loans for two of his trucks. The process involved one of his clients serving as a guarantor (co-signer) for the loan. To date he has obtained 2 loans for financing his truck purchases. The interest rate on the loan was 21% and the loan repayment period was 2 years. The first time he borrowed he ws required to have an equity down payment of 50%. For his second loan he was required to have 20%. Company 'B', another mechanical operator in Abuja, had attempted to access funds from

a government financing program and had not received a formal response to his loan application which was filed in 2008! All other operators self financed their businesses.

Of the three mechanical operators in Ibadan, only Company “B” had approached a cooperative society to finance two of his truck purchases. The prerequisite for financing was that he be a member of the cooperative and that he had made contributions of a certain amount. The interest rate for the loan received was 18% and the loan repayment period 10 months.

There are various banks in Nigeria e.g. the Urban Development Bank of Nigeria (UBDN), the Bank of Industry etc. with a mandate to provide financing for infrastructural projects and the growth of small and medium enterprises. Unfortunately, the projects and business enterprises focused on environmental solutions such as fecal sludge management seem not to attract too much interest or attention from these institutions that hold the keys to financing the implementation of these solutions.

For example, the UDBN’s mission Is to assist in addressing Nigeria’s infrastructure gap by facilitating private sector investments. The UDBN works with private sector clients to structure and package their financing needs for infrastructure investments in Nigeria e.g. Wastewater Treatment Plants. With only 44% of Nigeria’s population estimated to have access to improved sanitation facilities, the UDBN believes investing in Nigeria’s water infrastructure must be a key priority for sub-national governments. To date, the UDBN has not financed any projects in the water and sanitation sector. The banks borrowers include the various tiers of the government and the private sector. In order for the UDBN to extend loan facilities to the private sector for sanitation related businesses / projects, the private company must have a concession with the government for the WWTP, FSTP, Fertilizer plant etc. The loan terms seem favourable in that the bank provides 100% financing, the interest rate could be as low as 5% (current rate on the loans to transporters from the public mass transit fund), and the maximum loan period is 4 to 5 years.

Leasing may be a suitable alternative to purchasing used trucks which from the survey highlight the significant operations and maintenance costs associated with these used trucks. The

responsibility of maintaining the fleet would lie with the leasing company. It is anticipated that with the presence of leasing businesses dedicated or focused on waste management (solid and liquid), the operations and maintenance costs of the operators would be significantly reduced and more FSM SMEs can thrive without the burden of high O&M costs.

In Yenagoa, none of the operators approached the banks for loans. Most gave the reason that the banks were unlikely to assist them and their preference was to use whatever finances they had on hand. For those that had to refurbish their purchased trucks, this meant an additional delay in getting the business up and running.

No equipment leasing facilities exist in Ibadan for sewage trucks or other equipment required for the FS emptying and transportation business. Similarly, in Abuja, there are no FS evacuation and transportation equipment leasing centres. The emptiers do "function" as small scale equipment leasing centres for the Abuja Environmental Protection Board (AEPB) who has 2 trucks on retainer. The AEPB will occasionally rent trucks from emptiers when they have blockages in the sewer lines. In Yenagoa, however, one of the manual operators did indicate he leases a portable pump machine from those in the water supply business. The pump is also used for water so he ensures the equipment is properly cleaned after use and prior to return. It costs him NGN 7,000 (USD 47) to lease the pump for a day.

3.4.1.4 Role of Public Sector in Business Sustainability

The same incentives and partnerships existing in solid waste management should be extended to liquid waste management. To safeguard against indiscriminate dumping and to encourage other informal operators to formally register, the Ministry of Environment should play a key role in devoting financial and technical resources toward converting Sanyo from an experimental station to a full-fledged FS treatment facility.

What incentives can be proposed to facilitate mainstreaming? The monetary dis/incentives can take the form of penalties or subsidies. For example,

- Institute a penalty for not registering with the appropriate government agencies
- Institute a penalty for not discharging at FS authorised locations
- Subsidise fees for registration
- Subsidise rates (or provide rebates) on fertiliser purchases for discharging at authorised transfer stations

The government needs to prioritise and focus on realistic and implementable solutions. Rather than devoting financial resources to developing a centralised sewer system in an unplanned city like Ibadan, the government should focus on how to provide appropriate facilities for the disposal of evacuated FS. Based on the current situation at the Sanyo plant in Ibadan and the disposal site off Tombia road in Yenagoa, it is evident that government does not have the resources to operate and maintain the existing disposal facility. It is recommended that the government handover operations of the site to the private sector after site development.

3.4.1.5 Business Analysis of Treatment Plants in the Cities

The cities of Ibadan and Yenagoa require functional and adequate public FS disposal sites. This includes the establishment of intermediate transfer stations in addition to final disposal sites. There are no transfer stations in either of these cities and the emptiers have to travel an average of 20+km per trip. Currently, Ibadan has one public FS disposal site which was orignally designed as an experimental station. The Sanyo experimental station is clearly not adequate to service and meet the FS disposal needs of the city. The holding capacity of the stabilisation tank is 12.5m^3 which is the capacity of the largest truck in Ibadan's sewage truck fleet. This would imply that the Sanyo site should have a minimum of two 12.5m^3 stabilisation tanks in order to reduce bottlenecks at the plant. The government should either commit resources to upgrading the current disposal site or establish public-private partnerships to develop such facilities. The government can partner with the private sector to provide either one or multiple disposal sites (intermediate and final) across the city.

Abuja

Of the three cities surveyed, Abuja was the only city with a functional state of the art wastewater treatment plant owned and operated by the municipal (see Table 49). The WUPA wastewater treatment plant is located about 15km from the center of the city and was commissioned in 2007. The facility which is open daily does not receive trucks on site. The wastewater (including sewage sludge) is received via conveyance through the central sewer network. Waste evacuated from septic tanks by emptiers is discharged into manholes connected to the main sewer. The plant has a 0.7M PE capacity. However, only 30% of the Abuja population is connected to the central sewer network. There plant was designed with the intent to utilise the treated water for agricultural irrigation. The full potential of this beneficial use is yet to be realized. Table 40 illustrates the energy recovery potential assuming an existing anaerobic digester at the WUPA WWTP. The plant currently operates 24 hours daily and with the epileptic power supply situation across Nigeria, the plant spends approximately NGN 511,500 (USD 3,410) per day on diesel to fuel a 1300kw power generating set. Energy recovery from the wastewater can provide savings in fuel consumption as well as a reduction in environmental pollution (see Tables 87 and 88).

Table 91 WUPA Energy Recovery Potential

WUPA Influent flow Ga/day	Biogas (scf/d)	Methane (scf/d)	Electricity (KW)	Energy content (MMbtu/day)	Thermal Energy (Mmbtu/day)	% Energy contribution
10,566,880	105,669	63,401	232	68	29	0.02
15,850,320	158,503	95,102	349	103	44	0.03
23,775,480	237,755	142,653	523	154	65	0.04
34,672,575	346,726	208,035	763	224	95	0.06

1 Litre = 0.264172 Gallons

Table 92 Diesel Savings and CO2 Reductions from Energy Recovery

WUPA Wastewater Treatment Plant	No biogas utilisation based on influent of 40MLD	Biogas utilisation based on Influent of 40MLD	Biogas utilisation based on Influent of 60MLD	Biogas utilisation based on Influent of 90MLD	Biogas utilisation based on Influent of 131.25MLD*
Liters / month required for WWTP generator (1300kw)	100,386	98,591	97,693	96,347	94,496
Monthly Diesel[1] spend on WWTP generator (USD)	103,732	101,877	100,950	99,558	97,646
Annual Diesel spend on WWTP generator (USD)	1,244,786	1,222,527	1,211,397	1,194,702	1,171,746
Annual savings w biogas utilisation for power generation (USD)		(22,260)	(33,390)	(50,085)	(73,040)
Annual CO2 emissions (Tonnes)	3,224	3,167	3,138	3,094	3,035
Annual CO_2E emissions (Tonnes)	3,241	3,183	3,154	3,111	3,051
Estimated Annual Carbon Credit Revenues (USD)	16,207	15,917	15,772	15,555	15,256

*max influent capacity

USD exchange rate	**150**
Diesel price / liter (NGN)	**155**
Est. Carbon Credit price USD/tonne	**5**

MLD - million litres per day

[1]Price of Diesel bound to increase with subsidy removal

Ibadan

The Sanyo FS treatment plant is currently being maintained by the 3 registered mechanical operators at a cost of NGN1.5M (USD 10,000) per year. It was gathered from official sources that the cost of building this experimental FS disposal site was NGN 1.9M (USD 12,667). The disposal site contains the following structures:

- 1 stabilization tanks: 2.5m (L)× 2.5 m (B) × 2m (D)
- 1 manhole behind the stabilization tank which is used to check the FS flow into the beds and serves as a blockage clearing path
- 2X4 floating beds through which the FS passes before being discharged into the nearby stream (although only one set of 4 is operational – the second set is overgrown with weeds)

The site receives wastewater from industrial sites and fecal sludge from household septic tanks. The total holding capacity of the stabilization tank is $5m^3$ which is the capacity of the operator's smallest truck. Any blockage in the tank's outlet pipe could lead to delays in the discharging process. It is estimated that the Sanyo disposal site receives an annual volume of $53,743m^3$ of household and industrial wastewater including fecal sludge (Table 91). There is no form of pre-treatment of the wastewater discharged at the site. The small amount of dried sludge recovered from the floating beds is used for small-scale faming on-site by residents in the neighbourhood. There is no energy recovery taking place on site. Based on the current influent volume of $53,742m^3$, the wastewater has the potential of generating 4.1kw of electricity (Table 90).

Table 93 Annual Volume of Wastewater Discharged

Ibadan	Company A	Company B	Company C	Total
Total # of trips	2,078	3,118	1,511	6,707
Truck capacity (m^3)	9	6	12	
Total volume collected at Sanyo (m^3)	17,666	18,706	17,371	53,743

Table 94 Sanyo Potential Energy Recovery

Ibadan	WWGR (L/day)	Biogas (scf/d)	Methane (scf/d)	Electricity (KW)	Energy content (MMbtu/day)	Thermal Energy (Mmbtu/day)
Influent flow of 147,241 L/D	147,241.0	389.0	233.4	0.9	0.3	0.1
Buried FS 699,923 L/D	699,923.0	1,849.0	1,109.4	4.1	1.2	0.5

It is important to note that the Sanyo facility was neglected by the government after the site was constructed in 2008. There was no on-site maintenance or monitoring of activities and as a result the site was misused by operators. This led to complaints from the surrounding community and the site was closed from November 2010 to April 2011. The registered mechanical contractors were mandated by the government to rehabilitate the neglected site. The rehabilitation included constructing a fence, employing a site security guard, clearing the overgrown bushes and desludging of the floating beds.

3.4.1.6 Recommendations for Sustainable Business Models per City

The key requirement for any business model to be sustainable and effective is to have an established regulatory framework and enabling infrastructures in place. For FSM business models to be sustainable, the national environmental sanitation policy has to move from being a desktop paper document to being a living and practical document. Implementation of the FSM guidelines needs to be enforced by the responsible government agencies. There needs to be an enabling environment for the mechanical and manual operators to carry out services in a safe and business conducive environment. Adequate disposal facilities need to be constructed and in the wake of the current cholera epidemic in Ibadan, such measures are urgent and imperative. The government agencies should ensure appropriate laws are enacted and enforced to make it mandatory for all mechanical and manual emptiers to register with the appropriate agencies. Knowing who the service providers are in-city is a building block towards building a joint working partnership between the public and private sectors. Active monitoring

of registered service providers by the government authorities will ensure compliance with the applciable laws and regulations for fecal sludge (excreta) management. The government agencies need to move beyond their reputation as fee collecting agencies with nothing to show for the collected fees. It was interesting to note that none of the government agency representatives had copies of the policy readily available. The Ministry of Environment and Habitat and its agencies need to take the lead in implementation and this requires political will which seems to be lacking at the moment.

Frequency of Evacuation

Unlike solid waste which needs to be evacuated from households relatively frequently i.e. every few days, fecal sludge tends to be evacuated from households relatively infrequently. The frequency of evacuation is largely driven by the number of people using the facility, the size of the septic tank / pit latrine and the season of the year. On average households evacaute their facilities every few years and when the time comes for evacuation, a lump sum is typically demanded for the services rendered. Even though only 10% of the respondents indicated their preference for paying in installments, increasing the frequency of emptying during the year and charging by volume could ease the payment burden and also minimize environmental pollution problems. A recommendation would be to “sweep“ through the various cities according to a set time schedule. For example, the state / city environmental agencies mandating that evacautions be done of pit latrines every quarter or semi-annually or annually depending on the number of users of the facility. For example, a household of 6 in Ibadan can generate ~ 10 litres of FS per day (based on survey results). Assuming a 1,000 litre capacity manual evacuation; a household of 6 will need to be evacuated every quarter. The ‘sweep‘ would be monitored by the appropriate environmental agencies to ensure the emptying and transporation is carried out according to schedule and also in an environmentally safe manner.

Evacuation Process

Even though the Ministry of Environment and Habitat does not recognise manual emptying in the city of Ibadan, the survey results show that manual pit emptying will continue to play a

dominant role for decades to come in Ibadan. With 86% of the surveyed households patronizing manual emptiers, there is an imperative need therefore to develop technologies and collection strategies that reduce the health risks for emptiers and provide an enabling infrastructure for proper disposal of FS. The manual emptiers are a main link in the FS supply chain and there is the need to mainstream the informal sector that is currently on the fringes. Safer and affordable pit emptying technology (PET) solutions need to be developed and implemented in-country. In addition to the indigenous PETs, the Gulper, Nibbler, Vacutug etc. are examples of PETS introduced in other parts of Africa that can also be introduced and tested in the surveyed cities in Nigeria. The success of the pilot will determine the viability for scaling-up these PETs for the manual emptying process in Ibadan. The PETs need to be affordable and bear a comparable cost profile to the equipment currently used for manual emptying.

Collection and Transformation

Across the cities surveyed, the evacuated FS evacuated was not converted to beneficial use. Of the FS evacuated, only the fraction collected by mechanical emptiers was transported to a disposal facility. The fraction evacauated by manual emptiers was in most cases buried on-site. According to the survey results from Ibadan, 99.2% of the households bury the evacuated FS on-site or discharge it into nearby streams if the area is land constrained. The potential benefits of converting the FS to beneficial uses such as biogas utilisation and organic fertiliser are thereby lost by burying the evacuated sludge or not doing anything to it at the disposal site. To discourage burying of evacuated FS on-site, central disposal facilities ought to be developed within the various local government areas. Regulations also need to be enacted and enforced to mandate households and emptiers to dispose evacauted FS in authorised and conveniently situated transfer stations / collection centres. For manually evacuation, the FS can be collected in 500litre air-tight containers which can then be transported in wheelbarrows or by vehicle.The air-tight containers can either be purchased or leased for on-site use by the household. The household may then choose to recover the biogas from the air-tight container for energy generation or choose to have the container transported to the collection facility. The

transported air tight FS containers can then be discharged into larger tanks or larger capacity trucks at the collection facility.

Transformation of the FS to beneficial use can take place either at the potential transfer station / community BRC facility or at the larger FS treatment plant. Anaerobic digesters will be in operation at these locations for biogas recovery and composting. Potential biogas uses for in the communities would be cooking gas (most households are currently using kerosine).

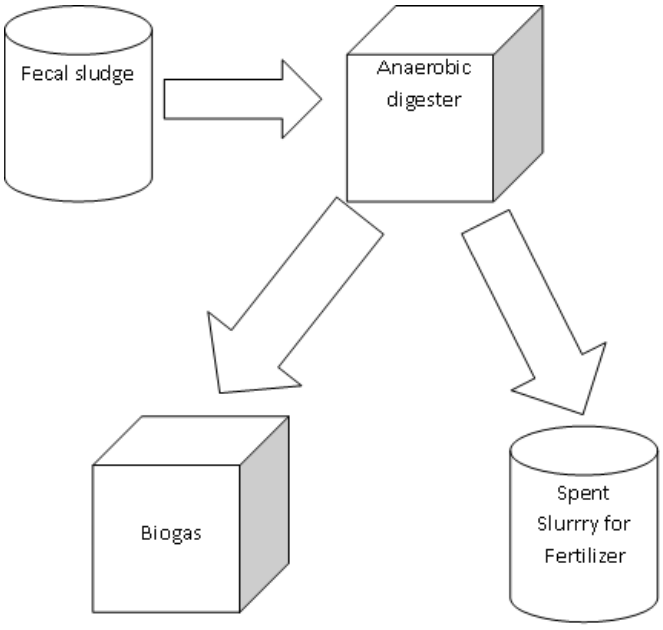


Figure 46 Conceptual Model for Sustainable Development

Carbon Credits

With the abatement and mitigation of methane emissions from the recovery and utilisation activity above, these solutions could be packaged as carbon finance projects. The reduction in methane emissions can then be traded for currency using existing carbon finance mechanisms like the Clean Development Mechanism, Gold Standard and Voluntary Carbon Standard. The establishment of community based biogas recovery and composting facilities could be

developed into a programme of activities in partnership with the communities for carbon financing.

3.4.2 Country level Analysis

3.4.2.1 Difference in parameters across three cities

Table 95 FSM Parameters across Cities

Country Parameters FSM Parameters	Abuja	Ibadan	Yenagoa
Active Government involvement in FS Emptying & Transportation	Yes	No. Limited involvement.	No. Limited involvement.
Government's current role in FSM	Oversight and maintenance of manholes; Operate and maintain the WWTP; Maintain the sewer lines; Provide emptying services to households and commercial entities	Strictly a fee collecting agency	Strictly a fee collecting agency
Private sector's current role in FSM	Emptying and Transportation services	Emptying and Transportation services	Emptying and Transportation services
Type of Disposal site	WWTP	FSTP	Open dump
Trucks received at disposal site	No	Yes	Yes
Adequate collection and transfer points for FS in the city	No	No	No
Public Sewer network	Yes	No	No

Government Owned Utility vehicles	Yes	No	No
Type of Emptying Service available	Manual / Mechanical	Manual / Mechanical	Manual / Mechanical
FS transfer stations / intermediary collection points	None	None	None
FS buried on-site after manual evacuation / discharged into nearby streams	Yes	Yes	Yes
Beneficial use of FS (Fertilizer, Energy)	None	None	None
Active Community Development Councils	Yes	Yes	Yes
Truck accessible neighbourhoods	Above average	Below average	Average
Organised platform for Emptiers	No	No	No

3.4.2.2 Recommendations for Sustainable Business Models across the Common Parameters

Upgraded FSTP Facilities

Upgrading the abandoned Sanyo FS treatment and transferring operations to a competent 3rd party operator. The existing facility is a glorified open dump site. New structures would need to be built which includes increasing the number of stabilisation tanks, drying beds and possibly adding a biogas recovery and composting facility on site. Similarly, the open dump site in Yenagoa would need to be upgraded to an FSTP which was the expressed desire of all the emptiers in Ibadan and Yenagoa. The government is a key stakeholder in any planned FSTP, however, we recommend that the FSTP in both cities be structured as a BOO or BOT after a stipulated lengthy time period. In Abuja the WUPA WWTP was financed by the government but constructed by SCC. The WWTP is operated by the government with technical assistance from

the project developers. Whilst the plant is running well (albeit underutilised), the long term sustenance of the plant is in jeopardy. The WWTP is not run as a profit center. Funds are allocated by the city for the operations and maintenance of the plant. The city government could wake up one day and indicate the funds for running the plant no longer exist!

The key to having an efficient and effectively run FSTP is to minimize government involvement in the operations of the FSTP. The building or development of the FSTP could be risky if left to the state government to handle and is a decision that needs to be weighed carefully.

Transfer Stations

None of the cities have intermediate FS transfer and collection stations. Abuja is the only exception because of the public sewer network. The manholes stationed around the city serve as pseudo transfer stations since the emptiers can discharge into certain manholes connected to the main sewer trunk lines. It is important to highlight the city has authorised discharge in only 2 out of the 8 manholes connected to the main trunk around the city. Transfer and collection stations need to be established. Establishment of central transfer stations and biogas recovery / composting (BRC) facilities within each of the 5 Ibadan LGAs. It is recommended that government own the facility but operations and maintenance be handed over to the private sector. These centrally located facilities would serve as collection points for FS evacuated from both pit latrines and septic tanks. The collected FS can then be converted to beneficial use i.e. power and organic fertiliser at transformation facilities owned by the surrounding communities. The establishment of these centrally located collection and transformation facilities would lead to the demand for small transportation service providers that can access neighbourhoods where roads are often impassable by larger utility vehicles.

Community Owned FS Transformation facilities

In Ibadan and Yengoa, we see the viability of establishing biogas recovery and composting facilities. Both cities seemed to have vibrant and active community development associations (CDAs). These CDAs facilitated the administration of the households within the various

communities. The survey results also highlight an interest by most to play an active role in FSM. By establishing coomunity owned FS transformation centres, the communities would be empowered to stimulate local economic development through the building of FS by product enterprises. The feed for the biogas recovery plant and composting plant will come from the transfer stations strategically placed within the LGAs. The beneficial products from the transformation facilties include energy, cooking fuel and organic fertiliser.

Truck Sourcing Options

- **Leasing Operations**

The leasing option for sewage trucks has not fully been exploited and can be established as a public private partnership. The capacity of FS Emptiers to purchase new sewage trucks that cost USD 83,000+ is quite low based on current economic and environmental conditions. Truck leasing businesses will enable mechanical and manual operators to have access to the equipment they need for providing emptying services at an affordable cost. No equity required and the burden of truck maintenance is shifted to the lessor. The concept of sewage truck leasing has existed on a small scale in Ibadan and currently exists in Abuja. In Ibadan, a couple of government bodies (i.e. Ministry of Works, Nigeria Prisons Service, and the Army) leased their sewage trucks to the public. The program worked for a while but collapsed due to the poor maintenance of the vehicles. No new investments were made once the trucks reached the end of their useful life. Since access to finance is a challenge for most Emptiers, we propose that state governments purchase new sewage trucks from domestic companies and transfer leasing management operations to financially capable and competent leasing management companies with proven track records in leasing operations and fleet management services. Alternatively, state governments can partner with leasing companies to handle both the purchase and management of the fleet of sewage vehicles. Interestingly, there is an umbrella organisation called ELAN (Equipment Leasing Association of Nigeria). Based on publicly available information, C&I Leasing Plc offers fleet management services and interestingly has the Hertz franchise in Nigeria. C&I Leasing Plc is a privately owned company and is the only quoted leasing company on the Nigeria Stock Exchange. Other competitor leasing companies include Asset Leasing Company of

Nigeria (ALCON0. The caveat emptor is that ALCON is a government run company and as such may not be profit oriented in its operations.

- **Domestic Truck Dealers**

Tata Motors of India has a sales showroom in Nigeria where they they sell heavy duty vehicles including new $6m^3$ sewage trucks. The $6m^3$ model, LPK 1618 cesspit tanker, is sold for NGN 12.2M (USD 81,333). The highest amount paid to purchase a truck by the emptiers was 53,333 which is USD 28,000 below the selling price of the LPK1618. The LPK1618 trucks are currently manufactured and assembled in India. However, there is potential that the body building of cesspit tank can be done in Nigeria. If done, locally this could perhaps further reduce the cost of the truck domestically. Alternatively, if the cost to fabricate in Nigeria does not result in lower manufacturing costs, outsourcing body building of the cesspit tank to neighbouring West African countries e.g. Ghana may be the most cost effective option. The free trade zone within the West African regional bloc will enable customers in Nigeria to benefit from lower production costs. The benefits of purchasing the LPK1618 from Tata include the service warranty which is 1 year or 40,000km and the presence of licensed Tata maintenance workshops in Lagos, Abuja, Kano, Port Harcourt, Ibadan and Enugu. Abuja and Ibadan were surveyed in this study and Yenagoa is approximately two hours by road from Port Harcourt.

Tata does not provide direct financing to customers. Instead they refer customers to domestic banks with whom they have relationships. No preferential treatment is given to the referred customers. The customers would be evaluated by the bank and if approved, the standard loan terms will apply.

3.5 Details and recommendation of at least one business ready for investment and growth

The business ready recommendations herewith are made with an underlying caveat that the enabling infrastructures for effective FSM are in place or plans are already in the works. The

National Environmental Sanitation Policy needs to be actively implemented and monitored in Ibadan and Yenagoa. There is evidence of the 2004 National Environmental Sanitation Policy (NESP) implementation in Abuja.

Aggressive implementation of the NESP will entail the following activities within each of the Local Governments at the Ward / District and Community levels.

- Education of government agency personnel responsible for implementation and enforcement of NESP
- Outreach and education of service providers (manual and mechanical); Requirements and expectations from service providers e.g. authorised disposal sites
- Outreach and education of community residents on FSM (excreta) management; Requirements and expectations from community residents e.g. frequency of evacuation, appropriate disposal of FS etc.

The team is also recommending that government address the urgent need for properly managed and operated fecal sludge disposal and treatment sites in Ibadan and Yenagoa. These sites should have the basic infrastructure to collect the daily quantity of fecal waste estimated for the city. The site should also have the infrastructure required to produce energy and fertiliser (anaerobic digesters), and compressor equipment to bottle the gas to be used as cooking fuel. These disposal sites would be pay per use sites. The emptiers in Yenagoa are currently paying annual disposal fees (to the community that owns the land).

3.5.1 Service Levels

Assuming the above prerequisites are in place, Ibadan presents for growth and development in FSM. It has the population to support and the current number of service providers for septic tanks is in short supply. According to Table 59, Ibadan has a deficit of 102 trucks to effectively handle the daily evacuation of septic tanks. Given the average truck capacity of 6.4m^3, approximately 166,000 emptying trips would need to be made annually to evacuate approximately 1,000,000m^3 of septic tank volumes. Current service levels are at 1% evacuation

of the total volume based on the number of trips taken annually. According to Table 60 (a more conservative estimate), Ibadan has a deficit of 11 trucks to effectively handle the daily evacuation of septic tanks. Given the average truck capacity of 6.4m^3, approximately 23,600 emptying trips would need to be made annually to evacuate approximately 141,800m^3 of septic tank volumes. Current service levels are at 10% evacuation of the total volume based on the number of trips taken annually.

It is important to note that the manual emptying business is just as important a service in the prevailing sanitation situation in Ibadan where 52% of the population use pit latrines. Basic equipment such as diggers, shovels, buckets and hoes are used to manually empty the pits in today's environment. The cost of environmentally safe pit emptying technologies is astronomically high when compared to the cost of basic equipment currently used by today's manual emptiers. On average, it costs the manual emptier between USD 25 – 35 for multipurpose equipment (digger, shovel, bucket, hoe) that can be used for at least 1 or 2 years before replacement. Pit emptying technologies such as the Gulper cost approximately USD 300 and can only be used for pit emptying (no multi-functional use).

3.5.2 Profitability

The profitability below reflects Company "B" in Ibadan. He is the sole emptier providing services to households now that company "C" is no longer emptying. It reflects providing 4% of the required services (960 trips annually). Household evacuation represents just 31% of the emptying services provided. The remaining 69% is provided to industrial and other commercial businesses.

3.5.3 Projected profitability in 3-5 years

Table 96 Five Year Profitability of Investment (5 new trucks)

Income Statement	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue	562,100	618,310	680,141	748,155	822,971
	-	-	-	-	-
Less operating expenses	428,564	459,220	493,349	531,297	573,447

EBITDA	133,536	159,090	186,792	216,858	249,524
	-	-	-	-	-
Less depreciation	81,333	81,333	81,333	81,333	81,333
EBIT	52,203	77,756	105,459	135,525	168,190
Interest	64,512	54,999	43,284	28,858	11,094
Gross taxable annual Income	116,715	132,756	148,743	164,383	179,284
		-	-	-	-
Total tax payable	3,693	6,827	18,652	32,000	47,129
EAITDA	120,408	125,929	130,091	132,383	132,155

5 year analysis

NPV @15% discount rate	**145,554**
After Tax Equity IRR - 5 years	**110%**
Pre-tax Equity IRR - 5 years	**129%**
Avg 5 yr monthly cash to operator (USD)	**3,924**

3.5.4 Investment required

In order to meet part of the demand for emptying services in Ibadan, the recommendation is for either Company "B" or "C" to increase the number of trucks in their fleet. A big assumption is that Company "C" is still opening to re-entering the business if the environment is conducive. The current truck deficit is 11 and we are assuming that each company will add 5 new trucks each, the $6m^3$ LPK1618 cesspit tanker from TATA motors.

Table 97 Data Parameters for New Truck Investments in Ibadan

Macro economic & business size data	
Inflation (CPI)	10%
Number of trucks	5

Revenue inputs	
Number of trips per annum	1,460
Average tariff per trip (USD)	77
Operating costs – Fixed	
Fixed annual salary costs	30,000
Office building rent	640
Telephone	
Electricity	56
Annual maintenance provision (% of I cost)	15%
Insurance (% of value)	5%
Misc other costs	8,000
Operating costs – Variable	
Fuel cost per litre	1.03
Consumption (litres per hour / Km per litre)	2.63
Average hours / KM per trip	15.00
Number of hours worked	21,900.00
Variable wages	1.50
Investment & finance costs	
Cost of new truck (USD)	81,333
Percentage Equity requirement	20%
Amount financed by equity	16,267
Amount financed by loan	65,067
Interest rate	21%
Number of installments	60

Monthly debt service payment	1,760
Depreciation rate	20%
Taxation	30%
Discount rate	15%
Sale of salvage discount over book value	30%

3.5.5 Risk analysis

Table 98 Trip Reduction by 50% - 730 per truck (Ibadan)

Income Statement	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue	281,050	309,155	340,071	374,078	411,485
	-	-	-	-	-
Less operating expenses	274,297	289,526	306,686	325,967	347,584
EBITDA	6,753	19,629	33,385	48,110	63,901
	-	-	-	-	-
Less depreciation	81,333	81,333	81,333	81,333	81,333
	-	-	-	-	-
EBIT	74,580	61,705	47,948	33,223	17,432
Interest	64,512	54,999	43,284	28,858	11,094
	-	-	-	-	-
Gross taxable annual Income	10,068	6,705	4,664	4,365	6,339
Total tax payable	41,728	35,011	27,370	18,624	8,558
EAITDA	31,660	28,306	22,706	14,260	2,219

Table 99 16% Reduction in Tariff (65USD)

Income Statement	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue	474,500	521,950	574,145	631,560	694,715
	-	-	-	-	-
Less operating expenses	428,564	459,220	493,349	531,297	573,447
EBITDA	45,936	62,730	80,796	100,262	121,269
	-	-	-	-	-
Less depreciation	81,333	81,333	81,333	81,333	81,333
	-	-	-		
EBIT	35,397	18,604	537	18,929	39,935
Interest	64,512	54,999	43,284	28,858	11,094
Gross taxable annual Income	29,115	36,396	42,747	47,787	51,029
					-
Total tax payable	29,973	22,081	13,147	2,979	8,652
EAITDA	59,088	58,477	55,894	50,766	42,376

5 year analysis

NPV @15% discount rate	**-135,519**
After Tax Equity IRR - 5 years	**Nil**
Pre-tax Equity IRR - 5 years	**Nil**
Avg 5 yr monthly cash to operator (USD)	**- 2,315**

4.0 Conclusion

A study has been carried out on the fecal sludge generation and management in 3 cities, Abuja, Ibadan and Yenagoa in Nigeria. Data was also collected on the FS emptying practices, the

available service providers, their investments, the condition of the trucks in use, costing and methods of disposal. The results indicated that FS is not collected efficiently and there is scope for business venture. The limitations for effective collection is lack of financial institutions to provide loans at a reasonable interest. At the moment used trucks are purchased and rehabilitated before putting them to use. From the data, it is evident that smaller capacity trucks have a wider margin in making profit. A few business models are described for early break-even and sustainable business development. The disposal practices in all the cities are not appropriate and there is need for developing efficient disposal facilities possibly with anaerobic digestion, tapping of biogas and converting the send slurry into fertilizer for agricultural use. Costing is given for various management operations in the whole process.

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Appendix 1

Table 100 Breakdown of household sample selection by locality in Ibadan Municipality

S/No.	Local Government Area	Locality Selected	Density Type	No. of Household for Interview
1	**Ibadan North**	Yemetu	High	18
2		Inalende	High	18
3		Kube Atenda	High	18
4		Sabo	High	19
5		Bashorun	Medium	19
6		Agbowo	Medium	19
7		Sango	Medium	19
8		Ashi	Medium	19
9		Mokola	Medium	18
10		Oke-Itunu	Medium	19
11		Oluwo-Nla	Medium	19
12		Samonda	Medium	19
13		Bodija	Low	18
14		Ikolaba	Low	18
15		Kongi	Low	18
16		Agodi	Low	18
	Sub-total			**296**
1	**Ibadan South East**	Bode	High	18
2		Oke-Oluokun	High	18
3		Ile-Titun	High	18

4		Kudeti	High	18
5		Odinjo	High	18
6		Odo-Oba	High	18
7		Felele	Medium	19
	Sub-Total			**120**
1	**Ibadan South West**	Oke-Foko	High	18
2		Ogunpa/Agbokojo	High	18
		Itamerin/Gege	High	18
3		Aregbeomo/Pooyemoja	High	18
4		Elewura	Medium	18
5		Apata	Medium	19
6		Odo-Ona	Medium	19
8		Oke-Ado	Medium	19
9		Adeoyo Hospital Ring Road	Medium	19
10		Gbekuba	Low	18
11		Oluyole Extension	Low	18
	Sub-Total			**202**
1	**Ibadan North East**	Aremo	High	18
2		Oke-Adu	High	18
3		Irefin	High	18
4		Oke-Offa	High	18
5		Oja Igbo	High	18
6		Oje	High	18
7		Orita -Aperin	Medium	18
8		Ita-Baale Oranyan	Medium	19
9		Idi-Ape	Low	19

	Sub-Total			**164**
1	**Ibadan North West**	Abebi	High	18
2		Agbeni	High	18
3		Oke-Are	High	18
4		Idi-Ikan	High	18
5		Eleyele Market	Medium	19
6		Ekotedo	Medium	19
7		Olopomewa	Medium	19
8		Idi-Ishin	Low	19
9		Onireke Link Reservation	Low	19
	Sub-Total			**167**
	Grand Total			**949**

Appendix 2

FS Production Spreadsheets

Abuja FS Production_Collection

Ibadan FS Production_Collection

Yenagoa FS Production_Collection

Mechanical Emptiers - Abuja.xlsx

Mechanical Emptiers - Ibadan.xls

Mechanical Emptiers - Yenagoa.xls

Appendix 3 – List of Interviewed Persons

Ibadan, Oyo State

Name	Job	Contact Details
Mr. Tunde Tairu	Director	Environmental Sanitation and Sewerage, Ministry of Environment, Oyo State
Mr. Ajibola	Deputy Director	Environmental Health Services, Ibadan North LG
Mr. Dayo Ayorinde	Project Manager	Sustainable Ibadan Project, Oyo State
Prof. A.T. Hassan (Owner)	Mechanical Emptier	35, Ososami Road, Oke Ado, Ibadan
Dr. Ketiku (Owner)	Mechanical Emptier	Benbow Specialist Hospital, Ibadan
Mr. Akinro (Owner)	Mechanical Emptier	Ph: +234 703 935 9870
Mr. Lekan Kehinde (Owner)	Mechanical Emptier (informal)	
Mr. Beckley (Owner)	Mechanical Emptier (informal)	
Mr. Muyideen Akeitan (Owner)	Mechanical Emptier (informal)	
Mr. Layode	Manual Emptier	
Mr. Owoeye	Manual Emptier	Ph: +234 704 404 1006
Mr. Ayuba	Manual Emptier	Ph: +234 705 694 1623
Mr. Akande	Manual Emptier	Ph: +234 802 325 68771
Imolede Organisation, Oje	Manual Emptier	Ph: +234 705 216 9274
Mr. Waheed Ajadi	Manual Emptier	
Mr. Hamidu Nasiru	Manual Emptier	Ph: +234 805 863 4597
Mr. Rasheed Akanmi	Manual Emptier	

Mr. Dauda Kolawole	Manual Emptier	
Mr. Bosun	Manual Emptier	
Mr. Lateef Amusa	Manual Emptier	Ph: +234 815 348 3048
Mr. Taye	Manual Emptier	
Mr. Bashir Akanbi	Manual Emptier	
Mr. Hamidu Adegoke	Manual Emptier	
Mr. Tunde Balogun	Manual Emptier	Itu-taba (Ile-Otun)
Baba Rilwan	Manual Emptier	Ph: +234 805 246 4532
Baba Ibeji	Manual Emptier	Ph: +234 807 895 9817
Baba Lagbaje	Manual Emptier	Ph: +234 704 275 2406
Baba Soldier	Manual Emptier	Ph: +234 704 303 2101

Abuja, FCT Abuja

Name	**Job**	**Contact Details**
Engr. Anthony Efediyi	Head of Department, Liquid Waste	Abuja Environmental Protection Board
Mr. Kabir Yari	National President, Nigerian Institute of Town Planners	Ph: +234 803 314 1100 Email: kmyari@mailnigeria.com
Engr. Emma Oluwadamisi	WUPA Wastewater Treatment Plant	Ph: +234 803 406 6869 Email: olu_emma@yahoo.com
Mr. Kola Olorunfemi (Owner)	Mechanical Emptier	Ph: +234 803 504 4990
Mr. Umar B. Gimba (Owner)	Mechanical Emptier	Ph: +234 803 614 1444
Mr. Bayo (Owner)	Mechanical Emptier	Ph: +234 803 320 8833
Mr. Sanni (Owner)	Mechanical Emptier (informal)	

Yenagoa, Bayelsa State

Name	Job	Contact Details
Mr. George Sinivie	Director	Environmental Health and Sanitation, Ministry of Environment, Yenagoa, Bayelsa
Mr. Francis Alagoa	Programme Manager	National Special Programme for Food Security, Bayelsa ADP
Mr. Binaebi Godspower (Owner)	Mechanical Emptier	Ph: +234 803 336 2428 Email: binalspringsglobal@yahoo.com
Mr. Saturday (Owner)	Mechanical Emptier	Ph: +234 706 676 6024
Mr. Michael (Owner)	Mechanical Emptier	Ph: +234 803 384 0162
Mr. Felix (Driver)	Mechanical Emptier	Ph: +234 706 560 9302
Mr. Tolumonye	Manual Emptier	Ph: +234 803 567 9504