CASE

Biogas from fecal sludge at Kibera communities at Nairobi (Umande Trust, Kenya)

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Supporting case for Business Model 3	
Location:	Nairobi, Kenya
Waste input type:	Fecal sludge
Value offer:	Sanitation service, energy for cooking and compost
Organization type:	Civil Society Organization (CSO) registered as a trust
Status of organization:	Operational since 2004
Scale of businesses:	Small
Major partners:	Athi Water Service Board (AWSB), Nairobi Water and Sewerage Company, Umande Trust, Local community, Water service providers

Executive summary

Umande Trust–TOSHA 1 is one of the bio-centres that Umande Trust has successfully implemented by working with residents organized in formal groups within the informal settlements to improve access to safe, adequate and affordable bio-sanitation and to provide income generating opportunities for the community. Umande Trust is a civil society organization (CSO) which works closely with community groups, public sector agencies, local government and peer civil society organizations to design, plan and construct bio-centres. The bio-centre is a multi-purpose facility consisting of toilet facilities, a rental space, a meeting hall and a bio-digester. It provides a range of services to the community, i.e. toilet service to the community, biogas cooking facility to women street food vendors, bio-slurry to farmers and a rental space to private businesses. Umande Trust offers technical support and builds capacity of the members of TOSHA 1 to run the bio-centre successfully. Using a pay-for-use revenue model, the bio-centre makes an average net income of nearly USD 1,100 per month. In order for the business to be successfully undertaken, the local communities are important stakeholders in the whole project, thus making community-led strategy the key success factor for the bio-centre. TOSHA 1 is used by an average of 1,000 people per day, making it one of Nairobi's busiest toilets and a producer of biogas. It is a good example of an environmentally-friendly approach to providing sanitation services through safe processing and disposal of human excreta while creating livelihood and jobs to the members of the community-based organization (CBO). A community-led approach to sanitation contributes to capacity building of the community and also to changing people's attitude towards use of human waste as a source of energy and business.

KEY PERFORMANCE INDICATORS (AS OF 2012)						
Land:	0.01 ha					
Capital investment:	USD 22,500 for construction of each bio-centre; USD 10,000 for advertisement/ campaign					
Labor:	Skilled and unskilled labor for construction and running the bio-centre					
O&M cost:	3,720 USD/year					
Output:	Toilet facility 1,000 users/day; Biogas capacity 54 m^3					
Potential social and/or environmental impact:	Improved community health, hygiene and environmental sanitation, improved livelihood and capacity building of community, job creation, reduced environmental pollution					
Financial viability indicators:	Payback period:	3 years	IRR:	33%	Profit margin:	77%

Context and background

Kenya with urbanization rate of 5% per annum has more than 1,800 low-income informal settlements with a total estimated population of 12.5 million. The informal settlements of Nairobi cover about 5% of the total residential land area but they are inhabited by over 50% of the city's total population. The characteristics of an informal settlement (slum) are: lack of basic water at affordable prices, sanitation by public or private toilets and other infrastructural services; unplanned, underserved, high density, poor neighbourhood without legal recognition or rights. Kibera is the largest slum in Nairobi and the largest urban slum in Africa. The 2009 Kenya Population and Housing Census reports Kibera's population as 170,070. About 85% of households buy water from privately or communally-owned kiosks at prices four to five times higher per litre than tariffs charged by the Nairobi Water and Sewerage Services Company. TOSHA 1 is a bio-centre within the informal settlements of Kibera managed by TOSHA[1], a CBO that is supported by Umande Trust in Kenya. The bio-centres are bio-sanitation units that provide secure and adequate access to sanitation and income generation by converting human waste into biogas and liquid fertilizer. Once the bio-centre is constructed, Umande Trust provides technical support and trains the CBOs to run and operate the bio-centre.

Market environment

Despite a number of efforts by a range of actors to improve sanitation, the majority of households in urban areas lack access to healthy and affordable sanitation facilities. Over 60% of the Nairobi population lives in informal settlements with only 25% of the households having access to a private toilet facility while 68% of informal settlement dwellers rely on shared toilet facilities and 6% have no access to toilets and have to use open areas or flying toilets. In addition to household sanitation problems, there is also the challenge of household energy for the urban poor. The high and rising cost of fuel (e.g. kerosene, charcoal, firewood) has been a challenge for the urban poor. The little resources allocated to sanitation were basically used for awareness creation and hygiene education, leaving the development of sanitation infrastructure lagging behind. Residents therein are often unhealthier than their rural counterparts because they are deprived of basic public social services, such as health care, water supply, sanitation and garbage disposal. Slum dwellers, exhibit relatively high mortality rates because they are less likely to access preventative and curative medical care despite their proximity to the best hospitals and clinics located in cities.

One of the support projects of the Athi Water Service Board (AWSB) is the construction of bio-centres in selected areas of informal settlements. Bio-centres are not only initiated in informal settlements but also in community facilities, such as schools and churches, making it easy and quick to reach a large number of people in the communities.

Macro-economic environment

For the purposes of achieving the initial Millennium Development Goals (MDGs) on water and sanitation, the Kenya government, in its Vision 2030, proposed improving waste management accessible to all through the design and application of economic incentives and the commissioning of public-private partnerships (PPPs) for improved efficiency in water and sanitation delivery. The government had also initiated a program to replace the slum with a residential district consisting of high-rise apartments, and to relocate the residents to these new buildings upon completion. The apartments are being built in phases in line with the government's budgetary allocations, and a few apartments in phase 1 of the project have been occupied.

Business model

TOSHA runs TOSHA 1, one of the profitable bio-centres set up by Umande Trust. It is used by an average of 1,000 people per day, making it one of Nairobi's busiest toilets and a producer of biogas (Figure 36). Using a pay-for-use revenue model, the bio-centre makes profit of about USD 1,100 per month. Umande Trust offers technical support and builds capacity of the members of TOSHA 1 to run the bio-centre successfully. In order to gain acceptance for the innovative sanitation approach, public awareness campaigns and trainings were done by Umande Trust. The demand for biogas and bio-slurry as an alternative source of energy and fertilizer is slowly gaining popularity. However, due to cultural and social beliefs and preferences a lot of public awareness campaigns have had to be

FIGURE 36. TOSHA 1 BUSINESS MODEL CANVAS

KEY PARTNERS
- Umande Trust
- Local community
- Water service providers
- Athi Water Service Board (AWSB)
- Nairobi Water and Sewerage Company
- International development agencies and foundations

KEY ACTIVITIES
- Public campaigns and training
- Engineering and construction of bio-centre (build, maintain and transfer)
- Operation and regular maintenance of bio-digester

KEY RESOURCES
- Technical know-how
- Unskilled labor
- Land
- Construction materials
- Human excreta
- Community leaders as endorsers

VALUE PROPOSITIONS
- Affordable toilet and bathroom facilities
- Provide cooking facilities (biogas) at a nominal fee
- Rental space at an affordable rate
- Affordable and high nutrient fertilizer

CUSTOMER RELATIONSHIPS
- Self-service, pay per use
- Self-service, agreement for a nominal fee
- Personal, rent agreement
- Personal, raising awareness through campaigns

CHANNELS
- Direct sales
- Direct sales
- Direct sales
- Direct, focus on awareness phase

CUSTOMER SEGMENTS
- Community
- Street food vendors
- Institutions and private business
- Farmers

COST STRUCTURE

- 10% profit share to Umande Trust
- Toilet facility cleaning
- Construction cost of bio-centre
- Campaign and training
- Operation and maintenance costs (Salaries, toilet consumables, water and electricity, bio-digester repair, etc.)

REVENUE STREAMS

- Toilet and bathroom service fee
- Fees from cooking facility
- Rent for business facilities
- (Future potential: Fertilizer sales)

SOCIAL & ENVIRONMENTAL COSTS

- Using bio-slurry for crops may potentially pose health risks due to possible pathogen survival
- Possible employee health risk while handling digested human excreta

SOCIAL & ENVIRONMENTAL BENEFITS

- Provide livelihood to the members of the CBO
- Improve community health, hygiene and environmental sanitation
- Environmental-friendly approach to providing sanitation services
- Safe processing and disposal of human excreta
- Reduce environmental pollution
- Capacity building of community
- Changing people's attitude towards use of human waste as a source of energy

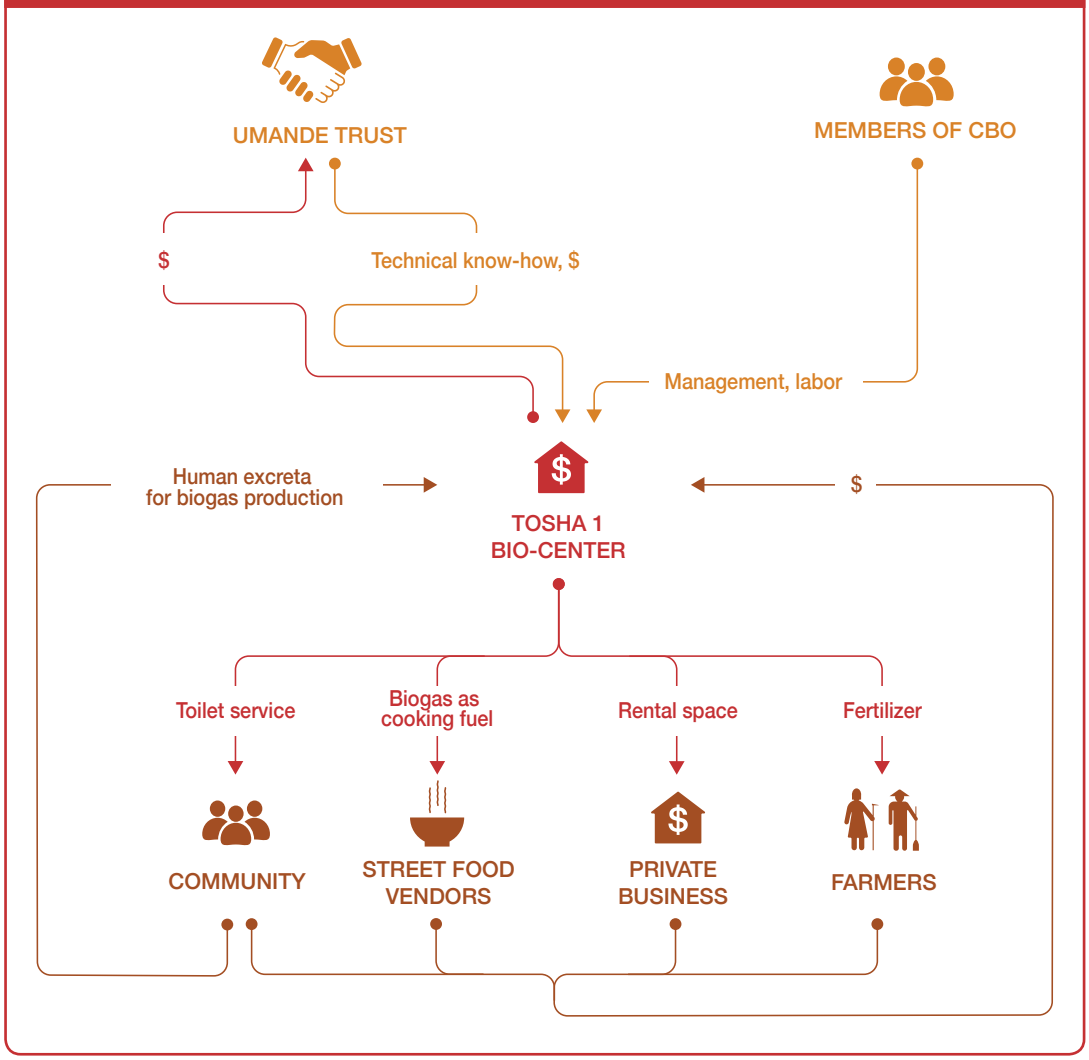
undertaken to break the stigma attached to using human waste by-products. The main customers using the facilities are the nearby residents, food vendors (mostly women), institutions and business people working at the market where the bio-centre is situated. Income generated from the bio-centre is shared amongst the members and 10% of its profit is given to Umande Trust.

Value chain and position

The value chain for TOHSHA 1 is depicted in Figure 37. Umande Trust is responsible for the plan, design and construction of the bio-centre and the success of the bio-centre by offering advisory support and also spearheading campaigns to promote the business activities. Before setting up a bio-centre, Umande Trust identifies, evaluates and selects existing organized groups or CBOs to run the bio-centre. Stakeholder workshops are undertaken to identify the site and the community is involved in selection of the best site. The user surveys, GIS mapping and participatory urban appraisal (PUA) processes ensure that individuals and community groups generate data on existing sanitation conditions and demands.

Once the project is completed, the CBO is trained on how to operate and manage the bio-centre. The TOSHA ensures that customers who come to use the facilities are served. The bio-sanitation centres charge 3 KSh per visit. The water kiosks within the bio-centres charge a flat rate of 5 KSh per 20 L jerry cans. Residents use facilities on a pay-for-use basis once a sponsoring agency provides investment funds for construction. It has also implemented two payment innovations: Beba pay (which exited the Kenyan market in 2015), a cashless system and Kopokopo, which reduce the use of cash handing and promote accountability.

FIGURE 37. TOSHA 1 BIO-CENTRE VALUE CHAIN



Institutional environment

The newly adopted Kenya Constitution has spelled out sanitation to be a human right, and the Ministry of Water and Irrigation (MWI) has drafted a new water policy and bill to align itself to the new constitution. Many sanitation stakeholders have embarked on efforts to improve sanitation situation in Kenya. These stakeholders include government ministries, national corporations and non-governmental Organizations (NGOs). The National Environment Management Authority (NEMA) is a government agency responsible for the management of the environment and the environmental policy of Kenya. The Ministry of Health (MOH) aims at an open defecation-free country by 2017 and has developed a roadmap to achieve this. The installation of bio-centres is part of the intervention targets under Nairobi Informal Settlements Water and Sanitation Improvement Programme (NISWASIP). Athi Water Service Board (AWSB) is one of the eight water boards under the Ministry of Environment, Water and Natural Resources created to bring about efficiency, economy and sustainability in the provision

of water and sewerage services in Kenya. The AWSB focuses on water and sanitation services to informal settlements by constructing bio-centres within its area of jurisdiction. Nairobi City Water and Sewerage Company is tasked to connect water to the bio-centres after completion. The plan was also aligned with the specific Millennium Development Goals (MDGs) on water and sanitation i.e. halving the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015.

Before the start of operation, to set-up a bio-centre, an environmental impact assessment (EIA) is required. There are two types of quality standards applicable to the bio-slurry: the agricultural standard and the NEMA standard. These quality standards require that the bio-slurry has to meet acceptable standards in order for it to be re-used in the farm and also to be safely disposed to the environment. The bio-slurry should be within recommended environmental guidelines.

The Water Services Trust Fund (WSTF) has developed a national sanitation concept for up-scaling public sanitation. Up-Scaling Basic Sanitation for the Urban Poor in Kenya-UBSUP-Kenya is a five-year program which is implemented by WSTF with support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The program is financially supported by KfW, a German financial cooperation, and the Bill and Melinda Gates Foundation (BMGF) and in kind by GIZ. The on-site sanitation systems will have a strong focus on sustainable fecal sludge management.

Technology and processes

TOSHA bio-centre consists of toilets, showers, operator's office, meeting hall, restaurant and a bio-digester. The technology used at TOSHA bio-centre is an adapted replication of the sanitation systems by Sulabh International Social Service Organisation in India. The bio-digester unit is an anaerobic treatment technology that produces biogas and a digested slurry that can be used as liquid fertilizer. The bio-digester is fed with the fecal sludge from the sanitation facilities equipped with flush toilets constructed within the bio-centre serving nearly 600–800 people per day. Each of the three states of matter are rendered useful: gas for the production of energy, liquid i.e. the treated water recycled and the treated solid waste used as fertilizer. The success of this technology depends on the proper construction of the bio-digesters. This means skilled labor is required during the setting-up phase. Umande Trust prefers this type of bio-digester due to the simplicity of construction, operation and maintenance.

The bio-digester is a fixed dome 54 m^3 reactor comprising of brick-constructed dome chamber that has been built below ground. In principle the hydraulic retention time (HRT) should be a minimum of 15 days in hot climates and 25 days in temperate climates as per the design criteria. Average HRT of the bio-digester is 20 days at an ambient average temperature of 25 °C. During operations, water is necessary for proper decomposition of the waste. Hence the operators ensure that despite water shortage, water is made available for flushing the toilets. However, due to insufficient water supply from the water service providers, water is flushed manually using tins from water drums that have been placed within the toilets. In order to avoid foreign objects (non-biodegradable) entering the bio-digester, a sieve is placed at the entrance to trap them. Once waste products enter the digestion chamber, gases are formed through fermentation. The gas forms in the sludge but collects at the top of the reactor, mixing the slurry as it rises. As gas is generated, it also exerts a pressure and displaces the slurry into an expansion chamber. When the gas is removed, the slurry will flow back down into the digestion chamber. The pressure generated can be used to transport the biogas through pipes. The slurry that is produced is rich in organics and nutrients and is almost odorless. No further treatment is done on the slurry, as tests done by Umande Trust, confirm that it is safe to be applied directly by farmers on their farms.

Funding and financial outlook

The general approach used by Umande Trust to construct the bio-centres for CBOs is that they obtain funds to construct the facility while the community would provide all unskilled labor required for construction. The bio-centre requires nearly 100 m^2 of land to construct it. The bio-centre was constructed on private land and hence there was no cost of land acquisition. The cost incurred to construct the bio-centre was nearly USD 22,500 (in 2006) and an additional USD 10,000 for campaigns and training to sensitize the community on the new technology to ensure successful implementation of the project (Table 12).

The main expenses incurred during the operation of the bio-centre include: cleaning the sanitation facilities, operation and maintenance of the facilities and employees to manage the facilities. As part of handing over the facilities to the CBO, Umande Trust ensures that the operators are well-trained to effectively operate and maintain the bio-centre. Campaigns to eradicate the stigma of using biogas and the bio-slurry are also undertaken by Umande Trust. This is done by involving leaders and respected men in the society to endorse the innovation during commissioning of the project.

TABLE 12. TOSHA 1 INVESTMENT, OPERATIONAL AND MARKETING COST

ITEM	AMOUNT (USD)
Investment cost:	
Construction cost	22,500
Campaign	10,000
Total	32,500
Annual operating and maintenance:	
Salary	1,800
Toilet paper	1,200
Water and electricity	240
Maintenance costs	100
Exhaustion services	380
Total cost	3,720

TABLE 13. FINANCIAL SUMMARY OF TOSHA 1 BIO-CENTRE

ITEM	AMOUNT (USD/YEAR)
Toilet services	13,920
Biogas	720
Rent (cyber)	1,200
Total revenue	15,840
Total cost	3,720
Operating profit	12,120
Payback period (years)	3 years
Net present value (NPV) (USD)	50,000
Internal rate of return (IRR) (%)	33%

The major income stream is from toilet services accounting for 88% of the total revenue (Table 13). TOSHA 1 is hardly getting any revenue from the bio-slurry due to personal distaste over using it as fertilizer. Assuming that profits and cash flows will continue to be the same in the future and assuming that useful life of the project is 20 years, the payback period is 3 years, the NPV is USD 50,000 and the internal rate of return is 33%. A future plan of the bio-centre is to containerize the biogas and sell it to individuals, institutions and hotels as an alternative source of energy.

Socio-economic, health and environmental impact

TOSHA 1 is a good example of an environmental-friendly and sustainable approach to providing sanitation services through safe processing and disposal of human excreta. About 1,000 men, women, youth and children from poor slum households have benefited from the bio-centre. The availability of business premises to individual business owners at an affordable rate has contributed to creating entrepreneurs in the community. The provision of clean toilets and bathrooms as well as a cooking area at a very affordable rate have improved the lives of the community residing near the bio-centres. In addition to these, a community-led approach to sanitation contributes to capacity building of the community and also to changing people's attitude towards use of human waste as a source of energy and business.

Amongst the key benefits would be improved health status of the general population with resultant significant savings from medical bills and improved social relations among neighbours who would now be sharing the same facilities. The project promotes renewable energy, helping the shift from the usual wood, charcoal, kerosene and gas to biogas for cooking. This helps in improving energy efficiency, reducing carbon dioxide emissions and alleviating pressure on forests. It is also cheaper and relatively affordable. The consistent participation of communities as shareholders (not stakeholders) is designed to promote ownership, the sharing of responsibilities and profits accruing from community-managed water and sanitation initiatives.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Lack of access to healthy and affordable sanitation facilities for households in urban areas.
- Government strategy, vision 2030 to improve waste management through application of economic incentives and appropriate PPPs.
- Community-led strategy to promote use of biogas and bio-slurry as alternative energy sources and fertilizer respectively.
- Sponsorship from various multilateral, bilateral and national entities.

Umande Trust is replicating this initiative on varying scales in Kenya using funds from sponsors who were encouraged by the success of the existing bio-centre projects. Umande Trust is planning to scale up the sizes of the bio-centres by increasing the size of the bio-digester and the number of latrines as well as commercial facilities. It plans to construct one large bio-centre where the other bio-centres can be emptied into so that they can generate more gas with a possibility of generating electricity. They also plan to construct a bio-centre that use solar and wind energy. With availability of financial resources the goal is also to containerize biogas or pipe it to nearby hotels to increase their sales. In order for this business to be successfully up-scaled and replicated in other locations, community-led strategy with sponsorship from various multilateral, bilateral and national entities is a key to the successful implementation of the project. Moreover, continued campaigns to promote use of biogas and bio-slurry as alternative energy sources and fertilizer respectively are needed.

Umande Trust and the communities have also formed a Sanitation Development Fund (SANDEF), a self-sustaining fund which loans out the funds needed to undertake a sanitation project. Government and NGOs can make a donation to SANDEF. It is after a project is completed that the loan will be repaid to SANDEF and those funds can be loaned out again for another project, hence multiplies the impact of donations.

Summary assessment – SWOT analysis

Key strengths of this business are implementing of community-led strategy and multiple revenue streams, which reduce the risk of failure (Figure 38). However, the business is highly subsidized and high dependence on donor grants pose sustainability issues.

FIGURE 38. SWOT ANALYSIS FOR TOSHA 1

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Community-led strategy ▪ Different revenue streams reduces risk of failure ▪ Strong partnership with local government and NGOs ▪ Low cost and environment-friendly proven technology	**WEAKNESSES** ▪ No immediate market for bio-slurry ▪ Highly subsidized (may pose difficulty in scaling-up) ▪ Limited technical and business skills of the community ▪ Inadequate space for sanitation development in low income urban areas
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Up-scaling potential ▪ Raising more funds from other sources (NGO or bilateral and multilateral entities) ▪ Development of a point-sales biogas market ▪ Unmet opportunities of ensuring access to basic sanitation for low income urban areas	**THREATS** ▪ Stigma against using human by-products and cultural barriers may lead to costly campaigns ▪ High dependence on donor grants pose sustainability issues ▪ Initial reluctance and lack of interest by community ▪ Too many fragmented actors in sanitation sector ▪ Most resources allocated on awareness creation rather than development of infrastructure

Contributors

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Case descriptions are based on primary and secondary data provided by case operators, insiders, or other stakeholders, and reflect our best knowledge at the time of the assessments (2015–2016). As business operations are dynamic, data can be subject to change.

Note

1 TOSHA stands for Total Sanitation and Hygiene Access and was founded in 2004 as a civil society network by the Umande Trust (in Swahili Tosha means 'adequate'). Over time many CBOs left TOSHA to establish their own bio-centres, resulting in a decentralized approach with wide outreach.