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PROFITABILITY OF A COMMUNITY-BASED, RESOURCES-ORIENTED HUMAN WASTE MANAGEMENT SYSTEM IN NAKURU, KENYA

Diplomarbeit

zur Erlangung des akademischen Grades

Diplomingenieur

eingereicht von:

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Dedicated to the children dying from diarrhoea.

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Abstract

Als eine der Hauptursachen für die Misserfolge von Projekten im sanitären Bereich in Entwicklungsländern gelten Schwierigkeiten im Aufbau eines nachhaltigen Betriebs- und Instandhaltungssystems. Ein Ansatz zur Bewältigung dieser Probleme im Rahmen eines ressourcenorientierten Sanitärkonzeptes in armen Stadtrandgebieten ist die Verwendung von Trocken-Trenntoiletten und die Einbindung von ortsansässigen Organisationen zur Gewährleistung der Betriebs- und Instandhaltung. In der vorliegenden Arbeit wird ein lokales Managementkonzept dargestellt und dessen Wirtschaftlichkeit mit Hilfe eines Business-Plans untersucht.

Das vorliegende Konzept für Nakuru, Kenia, basiert auf einer Organisation, die gegen eine Servicegebühr Fäkalien von Trocken-Trenntoiletten abholt, zu einer nahe gelegenen Kompostierungsanlage transportiert und diese mit organischen Abfällen co-kompostiert. Der produzierte Kompost wird an einen Hersteller organischen Düngers in Nakuru verkauft, der diesen weiterverarbeitet und an Landwirte vertreibt. Inwiefern dieses Konzept kostendeckend ist, ist sowohl bedeutend für die ökonomische Nachhaltigkeit der beteiligten Organisation als auch für die Instandhaltung und Nutzung der implementierten Trocken-Trenntoiletten. Darüber hinaus wird in der Arbeit untersucht, ob die involvierte Organisation als ein Sozialunternehmen geführt werden kann.

Die Ergebnisse zeigen, dass trotz anfänglicher wirtschaftlicher Einbußen und zusätzlicher Investitionen mittelfristig profitables Wirtschaften möglich ist und die Organisation darüber hinaus die Anforderungen eines Sozialunternehmens erfüllt.

Abstract in English

One main reason for the failure of sanitation projects in developing countries are difficulties in creating a sustainable operation and maintenance system. An approach to address this problem within a resources-oriented sanitation concept in poor, peri-urban areas is the use of Urine Diversion Dry Toilets (UDDTs) and the involvement of community based organisations to guarantee operation and maintenance. In this thesis a community-based resources-oriented human waste management concept is presented and its potential profitability is analysed by means of a business plan.

The presented concept for Nakuru, Kenya, is based on an organization that collects human waste from UDDTs for a service fee, transports it to a nearby composting facility and co-composts the human waste with organic waste. The compost produced is sold to a manufacturer of organic fertilizer in Nakuru where the compost is further processed and sold to farmers. To what extent this management concept can be operated cost effective is important for the economic sustainability of the participating organization and for the maintenance and use of the implemented UDDTs. In addition the thesis discusses whether the involved organisation can be recognised as a social business.

The results show that in spite of initial economic loss and additional investments in medium term a profitable operation is achievable. It is also shown that the organisation meets the requirements of a social business.

List of Abbreviations and Terminology

BEA	Breakeven analysis
BOKU	University of Natural Resources and Life Sciences Vienna
ca	circa
CBO	community based organisation
Eawag	Swiss Federal Institute of Aquatic Science and Technology
Ecosan	ecological sanitation
e.g.	exempli gratia; for example
et al.	et allii/iae; and others
GDP	gross domestic product
GTZ	German Agency for Technical Cooperation
EUR	Euro
Excreta	faecal matter and urine
Human waste	human faecal matter and urine
i.e.	id est; that is
kg	kilogram
KES	Kenyan Shilling
MEWAREMA	Menengai Waste Recyclers Management
MCN	Municipal Council of Nakuru
NAWACOM	Nakuru Waste Collectors and Recyclers Management
NAWASSCO	Nakuru Water and Sanitation Services Company Limited
NEC	Nakuru Environmental Consortium
No.	number
O&M	Operation and Maintenance
ROSA	Resource-Oriented Sanitation concepts for peri-urban areas in Africa
SANDEC	Department of Water and Sanitation in Developing Countries at the Eawag
SuSanA	Sustainable Sanitation Alliance
UDDT	Urine-Diversion Dry Toilet
UN	United Nations
USD	United States Dollar
WASREB	Water Services Regulatory Board
WASTE	Advisers on urban environment and development, Netherland
WEHAB	UN initiative on Water, Energy, Health, Agriculture and Biodiversity
WHO	World Health Organisation

Currency conversion

1 EUR = 108 KES = 1.37 USD (November 2010)

(In the research period this value varied from 1 EUR = 111 KES to 1 EUR = 98 KES)

1. Introduction

1.1 Background

About 230 children die every hour from diseases associated with the lack of safe drinking water and adequate sanitation (WEHAB, 2002). In Africa 60% of the urban dwellers have to live with sanitation facilities that pose a risk to their health and the environment (UN-HABITAT, 2003). The health and environmental risks result from different factors including: poverty, inadequate solid and human waste management, insufficient safe drinking water supply and a lack of awareness about hygiene. Thus human waste management is one important aspect in order to improve the sanitation, health and living conditions of the residents in urban and peri-urban low-income areas.

Most of the low-income urban or peri-urban areas in Africa are characterised by water scarcity and the neglection of infrastructural requirements by political authorities. Therefore conventional sanitation does not represent an appropriate solution in these areas (SANDEC, 2006). In comparison to conventional sanitation a sustainable sanitation system is not only economically viable, socially accepted, and technically and institutionally appropriate, it also protects the environment and the natural resources (SUSANA, 2008). Especially in East Africa, where depletion of soil fertility and food security are widespread problems, resource-oriented sanitation concepts can contribute to solve these problems, since they allow the recycling of nutrients in human excreta. However operating experiences in urban or peri-urban areas are very limited.

The project 'Resource-Oriented Sanitation concepts for peri-urban areas in Africa' (ROSA) aimed amongst others to research the gaps for the implementation of resource-oriented sanitation concepts in peri-urban areas in East Africa and to implement those in four pilot cities (Arba Minch, Ethiopia; Nakuru, Kenya; Arusha, Tanzania; and Kitgum, Uganda). The project started in October 2006 and ended in March 2010. Financed by the European Union the project involved local universities and municipalities of the mentioned four cities, supported by three European universities and two NGOs (LANGERGRABER et al., 2010).

One of the crucial points about sustainable human waste management is the sustainability of operation and maintenance of the system (SOHAIL et al., 2005, BRIKKÉ, 2000). Appropriate operation and maintenance concepts are specific to regional conditions. Therefore this thesis focuses only on Nakuru, Kenya. The potential cost effectiveness of a prospective operation and maintenance concept is one factor that influences its feasibility. In the course of a case study conducted in Nakuru in November 2009 relevant costs were identified in order to determine the potential profitability of a community-based, resources-oriented human waste management system.

1.2 Problem Definition

It is widely acknowledged that sustainability of sanitation infrastructure depends to a large extent on effective and efficient operation and maintenance (SOHAIL et al., 2005). Since the implementation of sustainable sanitation in densely populated, low-income peri-urban areas is a relatively new approach, data regarding management concepts of separated human waste in this specific areas are worldwide very limited. Moreover, financial data on the operational costs of small sanitation businesses in low-income areas are unavailable. The problem addressed in this thesis is if a resources-oriented sanitation concept can be operated profitably in Nakuru. This question is particularly important in regards to a sustainable operation and maintenance concept of sanitation facilities, which have been built during the ROSA project and replicated thereafter.

1.3 Research Objectives and Research Questions

This thesis aims at contributing to the available data on human waste management in low-income peri-urban areas. The objective of the research is to investigate if resources-oriented sanitation systems can be operated cost effective taking into account that collection, transport and treatment service of separated human waste is offered by a community–based organisation. Specifically for the case of Nakuru, the research objectives are to develop an operational concept and to analyse the potential profitability of a community-based human waste management system. The objectives of the thesis lead to the following research questions:

1. How can a collection, transport and treatment service of separated human waste be offered by a community-based organisation in peri-urban estates in Nakuru?
2. Can a community-based, resources-oriented human waste management system in Nakuru be operated cost-effectively?
3. Does the community-based organisation fulfil the objectives of a social business?

1.4 Structure of the thesis

The structure of the thesis is divided into six sections. Subsequently to this introduction follows a literature review that focuses exclusively on urban or peri-urban areas in developing countries and provides basic information about sanitation, ecological sanitation, urine diverting dry toilets, operation and maintenance of sanitation and sanitation as a business and social business. Chapter 3 commences with the conceptual framework presenting the ROSA project and the research area and ends with the derivation of two main hypotheses. The following chapter 4 describes the methodologies applied to gather relevant data and to test the hypothesis. The presentation of the results including an elaborated business plan and the verification of the hypotheses are given in chapter 5. The final chapter 6 is devoted to the discussion of the gained results including a critical examination of the limits of the applied business plan-methodology and recommendations to overcome identified challenges.

2. Fundamentals

This chapter focuses exclusively on developing countries and provides information about sanitation, resources-oriented sanitation, urine diverting dry toilets, operation and maintenance of sanitation and sanitation as a business and social business.

2.1 Sanitation

2.1.1 Definition

The world health organisation (WHO) defines sanitation as follows: “Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces. Inadequate sanitation is a major cause of disease worldwide and improving sanitation is known to have a significant beneficial impact on health both in households and across communities. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal“ (WHO, 2010).

According to EVANS (2004) sanitation consists of:

- „Safe collection, storage, treatment and disposal/ re-use/ recycling of **human excreta** (faeces and urine);
- Management/ re-use/ recycling of **solid wastes** (trash or rubbish);
- Drainage and disposal/ re-use/ recycling of **household wastewater** (grey water);
- Drainage of **storm water;**
- Treatment and disposal/ re-use/ recycling of **sewage effluents;**
- Collection and management of **industrial waste products;**
- Management of **hazardous wastes**, including hospital wastes, and chemical/ radioactive and other dangerous substances“.

Although the word “sanitation” comprises several components, this thesis focuses only on the management and reuse of human excreta in the following referred to as humane waste.

Sanitation chain and system

Sanitation includes a mix of hardware and software measures referred to as the sanitation chain. Generally the sanitation chain consists of confinement (the toilet seat and safe storage under the seat), removal and transportation of faecal sludge, subsequent treatment and disposal or re-use. In order to provide sanitation services to the poor at scale, service delivery processes (e.g. O&M) and further elements such as hygienic behaviour should be considered likewise (VERHAGEN and RYAN, 2008). Figure 1 illustrates the sanitation system components according to Tilley at al (2008): user interface, collection and storage or treatment, conveyance, (semi-) centralised treatment and finally use and or disposal. Re-use of sanitized human waste is however not foreseen in conventional systems.

Figure 1 Components of a sanitation system (adopted from TILLEY et al., 2008)

Sanitation facility

According to the WHO and UNICEF (2010) an improved sanitation facility is one that hygienically separates human excreta from human contact. Table 1 lists facilities regarded as improved or unimproved sanitation. This categorisation finds worldwide acceptance despite some controversial subjects. Malfunctioning treatment plants, leaking sewerage systems or overflowing septic tanks finds for instance no consideration despite its big impact on the urban environment and thus on human health (VERHAGEN and RYAN, 2008). However not all types of facilities are listed (e.g. UDDTs). Under certain conditions a shared facility can be regarded as improved sanitation as well.

Table 1 Improved and unimproved sanitation facilities (adopted from WHO and UNICEF, 2010)

Improved sanitation facilities	Unimproved sanitation facilities

▪ Flush or pour-flush to:
  o Piped sewer systems
  o Septic tank
  o pit latrine
▪ Ventilated improved pit latrine (VIP)
▪ Pit latrine with slab
▪ Composting toilet
	▪ Flush or pour flush to elsewhere
	▪ Pit latrine without slab/ open pit
	▪ Bucket
	▪ Hanging toilet or hanging latrine
	▪ Shared facilities
	▪ No facilities, bush or field

Most common are pit latrines, primarily because they are inexpensive and requires little or no infrastructure. But this method fails to contain and sanitize human excreta since pathogens and nutrients seep into the groundwater (ECOSANRES, 2008). Hence the sanitation chain described above does not apply for unimproved sanitation facilities except for shared facilities, which can be an improved facility in itself.

2.1.2 Access to sanitation worldwide

“Sanitation rarely receives the required attention and priority by politicians and civil societies” (SUSANA, 2008). This is probably one of the main reasons for the immense lack of adequate sanitation in developing countries. The most recent Joint Monitoring Programme estimates (WHO and UNICEF, 2010) describe the worldwide sanitation situation as follows:

- „Improved sanitation facilities are used by less than two thirds of the world population.
- The entire population of the developed regions uses improved facilities.
- In developing regions only around half the population uses improved sanitation.
- Among the 2.6 billion people in the world do not use improved sanitation facilities. The greatest numbers are in Southern Asia, but there are also large numbers in Eastern Asia and Sub-Saharan Africa (Figure 2).
- Seven out of ten people without improved sanitation live in rural areas.
- Because of a rapid growth in urban populations the number of people in these areas without improved sanitation is increasing.
- A growing number of people in urban areas defecate in the open.“

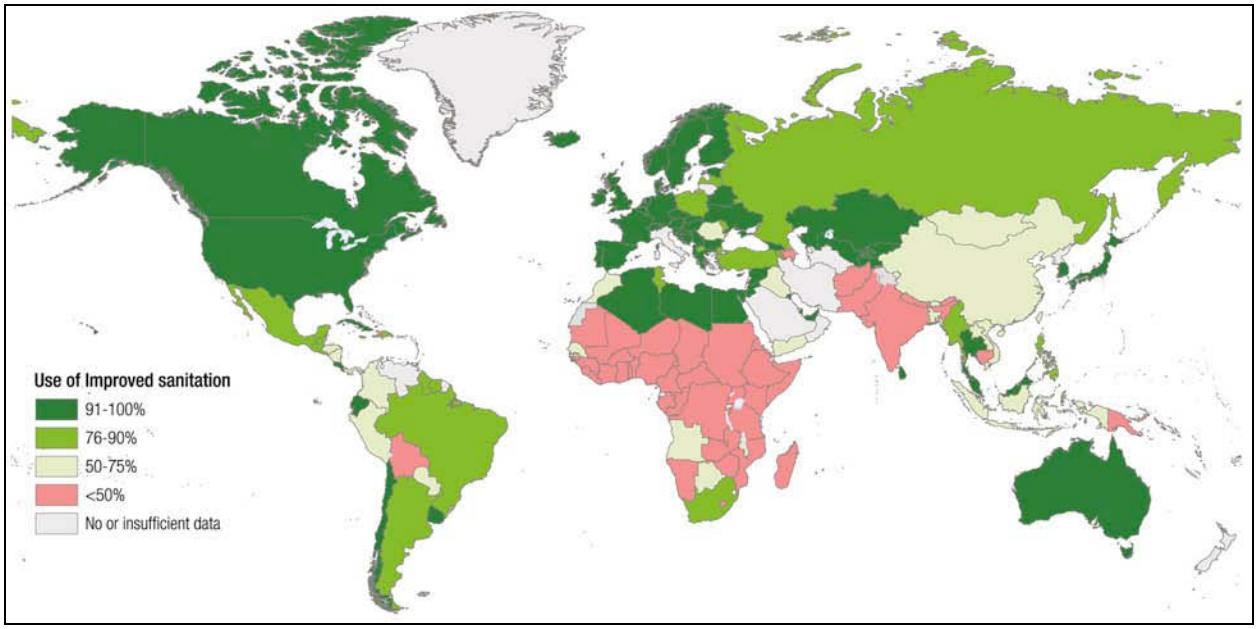

Figure 2 Worldwide use of improved sanitation facilities in 2008 (WHO and UNICEF, 2010)

Socioeconomic disparities in Sub Sahara Africa result in the fact that the poorest twenty percent of the population in Sub-Saharan Africa is around 16 times more likely to practise open defecation than the richest quintile (Figure 3).

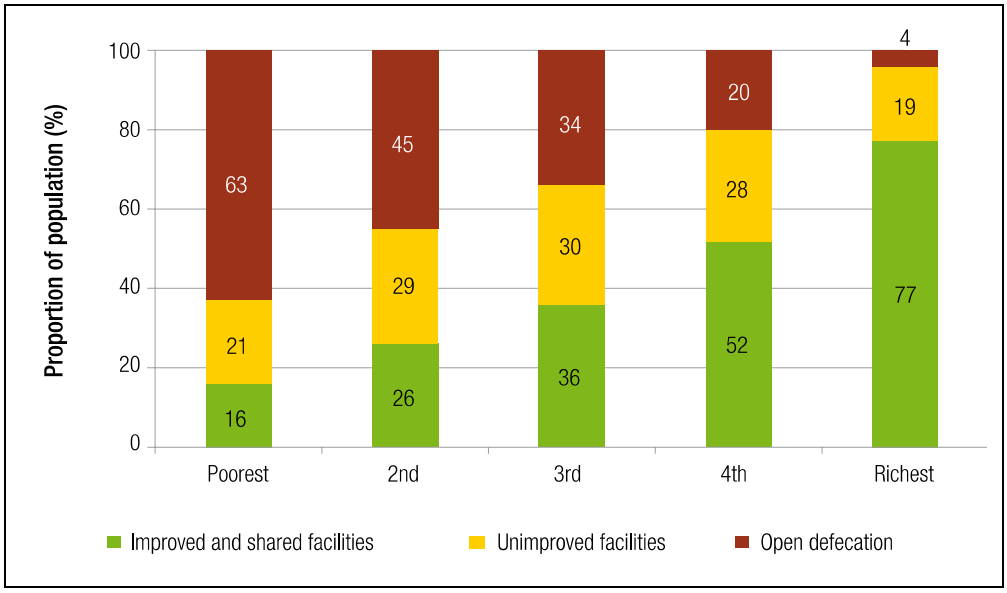

Figure 3 Usage of different sanitation facilities by wealth quintile in Sub Saharan Africa (WHO and UNICEF, 2010)

Although these figures are already highly alarming, they are supposed to be underestimated. “This figure (for the urban unserved) is reckoned to be an underestimate by today’s leading authorities on slum and squatter settlements, who believe that the invisibility of the poorest and most deprived urban populations in data collection obscures the fact that residents in the worst living environments have nothing resembling adequate sanitation” (Black and Fawcett, 2008 in VERHAGEN and RYAN, 2008, p. 2). The UN-HABITAT (2003) states that “[...] if assessment is widened to measure the proportion with access to safe water and those with access to clean toilet facilities the number of urban dwellers who are inadequately served is much higher than

officially acknowledged". Moreover the UN-HABITAT (2003) estimates that in Africa 150-180 million (ca. 50 -60 %) of urban dweller lack adequate sanitation.

2.1.3 Health effects of poor sanitation

"Pathogens and parasites found in human excreta, if ingested, can result in a variety of illnesses, including diarrhoea leading to malnutrition. If left untreated these illnesses can result in poor growth, iron deficiency (anaemia), vitamin A deficiency, and leave the body's immune system weakened and susceptible to more serious infections. Not all pathogens and parasites result in death, but the resulting malnutrition creates persistent poor health and a predisposition to disease and death from other causes" (ECOSANRES, 2008). In this way 2 million children die every year (5500 per day or 230 per hour) from diseases associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene (WEHAB, 2002). Hence people also need to adopt hygienic attitudes and have access to and exclusively drink clean water besides improved sanitation to reduce the incidence of diarrhoeal diseases (HEIERLI and FRIAS, 2007). Adults and children suffer from chronic diarrhoeal diseases or epidemic outbreaks (e.g. cholera), dehydration and anaemia. Children cannot attend schools, adults lose many working days, and families spend significant amounts for medicines and doctors visits (HEIERLI and FRIAS, 2007).

2.1.4 Economic impacts of poor sanitation

The Water and Sanitation Program (WSP) of the World Bank conducted a series of studies to estimates the economic costs of lack of sanitation, particularly health costs, productivity losses, tourism losses, drinking water treatment cost, and other welfare costs. The study focused on selected countries in the Asia and Pacific region. The central statement from these studies is: "Not doing anything about sanitation is costly; the economic impacts of poor sanitation are variable but high across all countries (ranging from 1 % to 7 % of GDP)" (ADB, 2009).

According to ONYANGO and ODHIAMBO (2009) treating diarrhoea consumes 10 % of the national health budget of Kenya.

The financial loss within the household results from the loss of income (incapable of work due to illness) and the money spend on health care and burials. Furthermore people (especially women) relying on open defecation waste time to find somewhere to defecate; this time is lost to household tasks, domestic production, childcare, education and paid work outside the family (SIJBESMA et al., 2008).

2.2 Resources-oriented / Ecological / Sustainable Sanitation

Resource-oriented sanitation, ecological sanitation (ecosan) and sustainable sanitation are different terms for the same approach of a sustainable utilisation of the resources human excreta and wastewater by closing the material flow cycles. According to WERNER et al. (2004) it aims at:

- Reducing the health risk related to sanitation, contaminated water and waste,
- Improving the quality of surface and groundwater,
- Improving soil fertility and
- Optimising the management of nutrients and water resources.

The Sustainable Sanitation Alliance (SuSanA) is a network of 123 international, regional and local organisations and research institutions from 45 countries that share a common vision on sustainable sanitation. SuSanA (2008) is defining sustainable sanitation as follows:

„ In order to be sustainable, a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources".

When improving an existing and/ or designing a new sanitation system, sustainability criteria related to the following aspects should be considered (SuSanA, 2008):

1. **"Health and hygiene:** includes the risk of exposure to pathogens and hazardous substances that could affect public health at all points of the sanitation system from the toilet via the collection and treatment system to the point of reuse or disposal and downstream populations. This topic also covers aspects such as hygiene, nutrition and improvement of livelihood achieved by the application of a certain sanitation system, as well as downstream effects.
2. **Environment and natural resources:** involves the required energy, water and other natural resources for construction, operation and maintenance of the system, as well as the potential emissions to the environment resulting from its use. It also includes the degree of recycling and reuse practiced and the effects of these (e.g. reusing wastewater; returning nutrients and organic material to agriculture), and the protection of other non-renewable resources, e.g. through the production of renewable energies (such as biogas).
3. **Technology and operation:** incorporates the functionality and the ease with which the entire system including the collection, transport, treatment and reuse and/or final disposal can be constructed, operated and monitored by the local community and/or the technical teams of the local utilities. Furthermore, the robustness of the system, its vulnerability towards power cuts, water shortages, floods, earthquakes etc. and the flexibility and adaptability of its technical elements to the existing infrastructure and to demographic and socio-economic developments are important aspects.
4. **Financial and economic issues:** relate to the capacity of households and communities to pay for sanitation, including the construction, operation, maintenance and necessary reinvestments in the system. Besides the evaluation of these direct costs also direct benefits e.g. from recycled products (soil conditioner, fertiliser, energy and reclaimed water) and external costs and benefits have to be taken into account. Such external costs are e.g. environmental pollution and health hazards, while benefits include increased agricultural productivity and subsistence economy, employment creation, improved health and reduced environmental risks.
5. **Socio-cultural and institutional aspects:** the criteria in this category refer to the socio-cultural acceptance and appropriateness of the system, convenience, system perceptions, gender issues and impacts on human dignity, the contribution to food security, compliance with the legal framework and stable and efficient institutional settings."

Sanitation projects have to address all of these five sustainable criteria in order to be successful. Furthermore the following basic principles known as the "Bellagio Principles for Sustainable Sanitation" need to be considered (WSSCC, 2000):

1. „Human dignity, quality of life and environmental security at household level should be at the centre of the new approach, which should be responsive and accountable to needs and demands in the local and national setting.
   - Solutions should be tailored to the full spectrum of social, economic, health and environmental concerns.
   - The household and community environment should be protected.

- The economic opportunities of waste recovery and use should be harnessed.

2. In line with good governance principles, decision-making should involve participation of all stakeholders, especially the consumers and providers of services.
   - Decision-making at all levels should be based on informed choices.
   - Incentives for provision and consumption of services and facilities should be.
   - Consistent with the overall goal and objective.
   - Rights of consumers and providers should be balanced by responsibilities to the wider human community and environment.
3. Waste should be considered a resource, and its management should be holistic and form part of integrated water resources, nutrient flows and waste management processes.
   - Inputs should be reduced so as to promote efficiency and water and environmental security.
   - Exports of waste should be minimised to promote efficiency and reduce the spread of pollution.
   - Wastewater should be recycled and added to the water budget.
4. The domain in which environmental sanitation problems are resolved should be kept to the minimum practicable size (household, community, town, district, catchment, city) and wastes diluted as little as possible.
   - Waste should be managed as close as possible to its source.
   - Water should be minimally used to transport waste.
   - Additional technologies for waste sanitisation and reuse should be developed“

Thus resources-oriented sanitation’s holistic strategies promote interdisciplinary approaches for (GTZ, 2005 in HEEB, 2007):

- Agriculture (marketing recovered nutrients & applying them safely in agriculture),
- Food security,
- Health care (raising public awareness, improving hygiene),
- Economics (establishing a service business for building and operating the installations),
- Urban planning,
- Waste management in general.

Resources-oriented sanitation offers a number of appropriate solutions for different situations worldwide. Technologies applied range from natural wastewater treatment techniques to compost toilets, simple household installations to complex, mainly decentralized systems. A summary of approaches concerning the collection, treatment and utilisation of organic solid waste, faeces, urine, greywater, and rainwater is given in Figure 4.

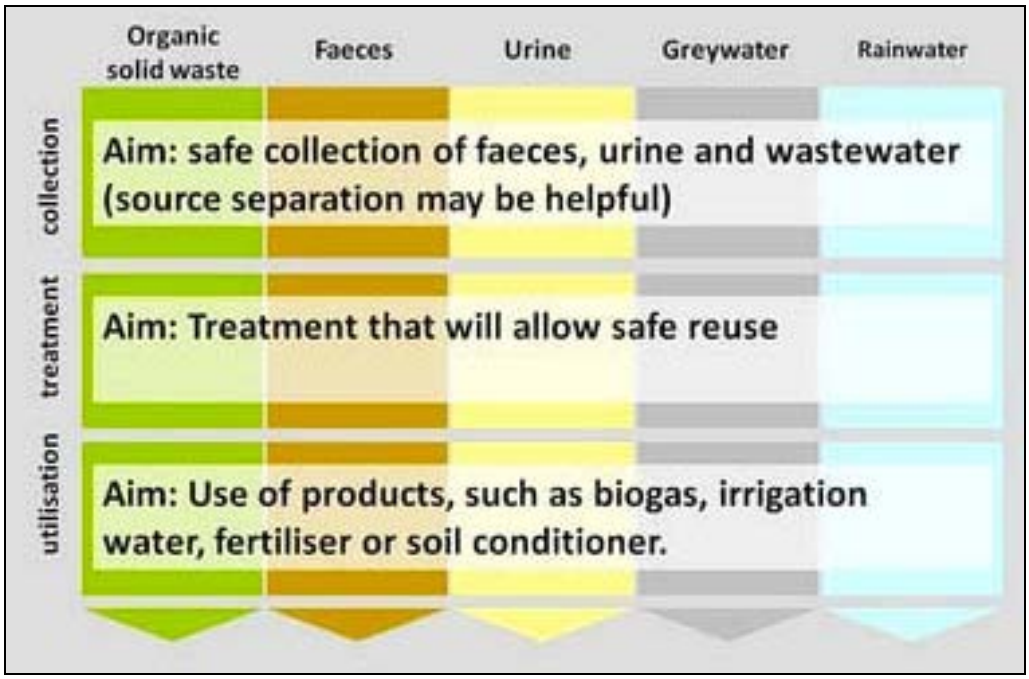

Figure 4 Resources-oriented sanitation approaches (GTZ, 2010)

2.3 Urine diverting dry toilets

In the ROSA project (described in chapter 3.1 and 3.3) Urine Diverting Dry Toilets (UDDTs) have been implemented in Nakuru and will therefore be described in detail in this chapter.

In UDDTs urine and faeces are separately collected and no water is required for flushing. Urine is captured in the front of the toilet from where it is drained off to a storage container. Faeces are stored directly beneath the toilet in movable container inside a chamber. After each defecation, dry soil, ash, lime or sawdust is spread over the faeces, controlling odour, reducing flies and absorbing moisture. Furthermore it makes the pile less compact and depending on the additive, increases the pH content, which enhances bacterial pathogen die-off (WASTE et al., 2006, MÜNCH, 2009). When the faecal matter container is nearly full, an empty one replaces it. The full container can be left next to the empty one in the chamber for storage and drying of faeces, before they are collected and converted into soil conditioner or fertilizer (MÜNCH, 2009).

2.3.1 Applicability

In general UDDTs are suitable for areas with sufficient public awareness about the risks of handling urine and faeces. UDDTS are particularly suitable in regions

- that are water scarce,
- that are flood prone, or that have an impermeable and a high ground water table, hence potential for groundwater infiltration (WASTE et al., 2006),
- where urine and faeces can be used in agriculture (rural and peri-urban areas). (WASTE et al., 2006) and agricultural yields are low caused by depleted soils (ONYANGO and ODHIAMBO, 2009),
- with unfavourable soil conditions hard, rocky surface or unstable soils (MÜNCH, 2009),
- with high incidence of waterborne disease, especially routine cholera outbreaks (ONYANGO and ODHIAMBO, 2009).

2.3.2 Structure

A UDDT consist of a toilet seat or a squatting pan, with urine diversion. Those can be made out of ceramic, ferro-cement, fibre-enforced materials, or strong, durable, plastic and painted wood (MÜNCH, 2009). The Figure 5 and Figure 6 show toilet interfaces used in Nakuru.

Figure 5 Squatting pan of an UDDT

Figure 6 Plastic toilet seat of an UDDT

The toilet interface is located above a ventilated and accessible chamber (Figure 7), where movable containers are stored (Figure 8). Containers can be of plastic, metal or any other impervious material and of variable size. The volume is generally less than 100 litres, to allow easy removal of the full container (MÜNCH, 2009). Toilet paper can be thrown into the faecal matter container but additional menstrual management requirements of adolescent girls and women need to be provided (MÜNCH, 2009). UDDTs can also be used in combination with a special anal washing facility. Washing water has to be collected separately (WASTE et al., 2006).

Figure 7 The rear of the facility, drying chamber

Figure 8 Faecal matter container inside the drying chamber

2.3.3 Sanitation chain and nutrient recovery

As stated in chapter 2.1.1 a sanitation system or sanitation chain consists of different elements from user interface to use or disposal. Figure 9 presents the general sanitation system with UDDTs according to TILLEY et al. (2008).

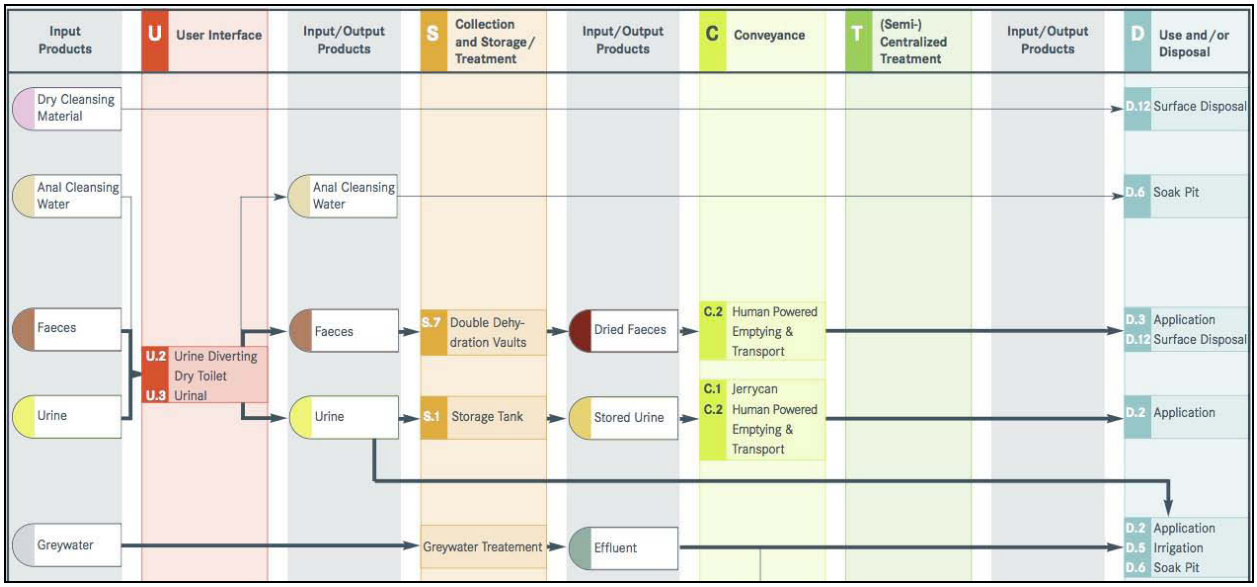

Figure 9 Waterless sanitation system with urine-diversion dry toilets (TILLEY et al., 2008)

In comparison to the system above the specific sanitation system with UDDTs in Nakuru includes a centralised second treatment of human waste via co-composting subsequent to the organized collection and transport of fermented (first treatment) faecal matter from several UDDTs (Figure 10).

Figure 10 Sanitation chain with UDDTs in Nakuru

Resources-oriented sanitation concepts aim at closing material flow cycles. By means of UDDTs the reuse of nutrients (phosphor, nitrogen, etc.) in human excreta by agriculture is feasible and therefore closes the nutrients cycle (Figure 11).

Figure 11 Ecological cycle of nutrient recovery (adopted from: ESREY et al., 2001)

Urine reuse in Kenya

In Kenya food production has declined, largely as a result of rapid land degradation. Depletion of nutrients and soil organic matter and erosion are some of the major problems facing agricultural production in Kenyan smallholder farms today (ECOTACT, 2010)

Normal urine excretion of an average person is 1-2 litres per day. The average nutritional content varies worldwide due to the difference in regional diets, in Kenya the values in urine and in faeces per person per year are shown in Table 2.

Table 2 Nutritional content of excreta per person per year, in Kenya (ECOTACT, 2010)

	in urine (kg)	in faeces (kg)
Nitrogen (N)	2.4	0.3
Phosphorous (P)	0.3	0.1
Potassium (K)	1.1	0.4

Separated urine can be used as an alternative to artificial fertiliser. Even though the use of excreta in agriculture is still prohibited in Kenya currently promising researches of the Jomo Kenyatta University investigate the possibility to use urea in urine to produce eco fertilizer. This Urea conversion research is supposed to be a major scientific breakthrough in Kenya, by ensuring locally manufactured, high quality and affordable urea products with specific agronomic variability. According to ECOTACT this „presents a solution for 21st century agricultural problem in Africa and beyond“ (2010, homepage). The research results were expected to be ready until April 2010 but have nor yet (Nov 2010) been published.

2.3.4 Operation and maintenance

Regarding maintenance cleaning of the facility is necessary at household level whereby it has to be considered that water and chemicals should not enter the container beneath the squatting pan or toilet seat.

The main operational requirement when using UDDTs is to keep the faeces container dry by adding dry material, which has to be always available. Furthermore filled faecal matter containers have to be replaced by empty ones. The frequency of the replacement depends on the number of user and the volume of container.

In urban or peri-urban areas technical maintenance work (repairing blocked urine pipes) and further processes of the sanitation chain should be provided by a collection transport and treatment service to guaranty a sanitisation of excreta according to WHO guidelines. Otherwise the UDDT owner requires additional space for further treatment and reuse on-site. A detailed list of the maintenance and operation requirements (MÜNCH, 2009) can be found in appendix 1.

2.3.5 Health risks

A UDDT can transform infectious faeces into a safe product, if storage times are respected and the UDDT is operated correctly. The main health and environmental risks of UDDTs result from poor operation and maintenance. If the necessary storage time is not respected, safety of the content cannot be guaranteed and people may handle infectious matter. Poor design and neglect of adding dry and alkaline adsorbents also decreases safety (MÜNCH, 2009).

The health risk especially from movable container systems arise from the fact that containers have to be moved when there is still partially fresh material inside. Furthermore are systems with larger chambers, allowing the full container to be stored within the chamber itself safer than systems where the full container with fresh material has to be taken away immediately (MÜNCH, 2009). Because of the generally shorter storage time (lack of space on site) dried faeces have to be further stored or treated before safe reuse. The WHO (2006) suggests in temperatures of 20 to 35°C a storage time of dry faeces of 6 month for alkaline treatment (raising the pH to > 9) and a storage time of one month for urine to guaranty a hygienically safe reuse.

Further health and environmental risks result from the presence of micropollutants such as pharmaceutical residues or hormones in urban effluent. Micropollutants are only partly eliminated at conventional wastewater treatment plants and in treatment processes within ecosan systems. Micropollutants released into the environment are subject to various transformation processes. In addition to the parent compounds, the emerging transformation products may pose risks to human health and the environment due to their bioaccumulation potential and their toxicity. According to SCHIRMER (2009) little is known yet about the possible impacts of micropollutants on aquatic organisms and ecosystems. „The difficulty of establishing a causal link between a micropollutant and a change in an ecosystem is shown by the example of estrogenic substances. These compounds act in a similar way to the female sex hormone estradiol and are thus able to disrupt the endocrine system in animals. The list of estrogenic substances widely found in natural waters includes not only the synthetic estrogen ethinyl estradiol, which is used as an oral contraceptive, but also bisphenol A, which is added to various plastics as a softening agent“ (SCHIRMER, 2009, p. 4).

2.3.6 Advantages and disadvantages

According to WASTE et al. (2006) and MÜNCH (2009) advantages and disadvantages of UDDTs are the following.

Advantages:

- No water required for flushing.
- The public health risks are mainly limited to proper handling of faeces.
- Removal of the small, dehydrated volume of faeces from the UDDT is easier and more hygienic
- Large-scale nutrient recovery is a realistic possibility.
- Can be used indoors.
- Easy to construct with local materials.

- Permanent structure (in comparison to abandoned pit latrines)
- Due to urine diversion, drainage of liquids can be avoided and pathogens and nutrients be confined to the containers.

Disadvantages:

- Operation requires clear instructions and close attention.
- Regular removal of collected urine and faeces is required.
- The toilet has to be cleaned without using much water.
- Collected excreta have to be handled carefully, as they contain pathogens.
- Special child seats have to be provided to keep their urine and faeces separate.

2.3.7 Costs and Benefits

Costs

The cost structure of UDDTs is presented in comparison to different systems in Table 3 However this statement of costs does not comprise maintenance cost, cost for soft-investments (like capacity building, training and hygiene education) and the treatment cost of human excreta within conventional and resources-oriented sanitation systems. Furthermore details on the full-life-cycle cost of water, sanitation and hygiene services are not available (WASHCost Project (2008-2012) in SIJBESMA et al., 2008).

Table 3 Cost structures of different sanitation options (adopted from: SIJBESMA et al., 2008)

	Conventional individual toilets	Shared toilets	UDDT (double-vault, one-door)
Capital investment	USD 28 to 54 (basic) USD 68 to 500 (complete)	More expensive than Individual toilets (higher quality materials to allow for more intensive use and ease of cleaning)	USD 300 (simple super- and sub-structure) USD 650 (elaborated super und sub-structure)
Recurrent cost daily	Small (soap, paper, water)	Per visit	Small (soap, paper, water, dry material)
Recurrent cost monthly	-	USD 3 (India 10 % of income)	up to USD 1 (depending on operational method and household's size)
Recurrent cost 2 to 5 years	USD15 to 25 (manual) USD132 (improved manual) USD73 to 246 (truck)	-	-

Capital investment

"Construction of a UDDT in most cases can be done with locally available materials and labour. Prefabricated parts may include toilet seats or squatting pans. If those parts do not need to be imported from abroad, they are usually cheap and can be even cheaper than self constructed squatting pans made from cement. Squatting pans made of ceramics are also available which are not very costly and easy to maintain" (MÜNCH, 2009 p. 6).

A study published by GTZ (BLUME, 2009) on the cost optimisation of single door UDDTs in Kenya reveals the following:

- The current total costs of a one-door, double-vault UDDT are 51,000 KES per unit.
- The ratio of material to labour cost is 80 % to 20 %. (41,000 KES compared to 10,000 KES).
- Highest material costs are caused by cement (9,600 KES – 23 % of material cost), building sand (5,270 KES – 13 %), burned bricks (4,080 KES – 10 %) and the squatting pan (3,500 KES – 9 %).
- Highest labour costs are caused by the construction of walls with five days of skilled (2,500 KES) and unskilled labour (1,250 KES).

This study revealed furthermore that the construction costs could be reduced by almost 40 % when simple materials are used for super structure and local solutions for rainwater harvesting are applied. „Further cost reductions might be possible if the sub-structure and toilet slab would be constructed in a simpler way“ (BLUME, 2009).

In the course of the ROSA project a cost estimation by MUCHIRI (2009) shows that the cost for two single vault UDDTS and two Bathrooms can be estimated at 108,300 KES in Nakuru. A detailed bill of quantities can be found in appendix 2.

Benefits

In a more densely populated settlement, like in peri-urban areas of Nakuru, where direct use of sanitation products is not possible, the economic benefits arise from the fact that households have a permanent toilet system that can be emptied without the aid of vacuum truck. “In the long-run this can be represented as a significant savings for households over the use of pit or VIP latrines, or even over conventional flush toilets (MÜNCH, 2009)”. In addition is the manual emptying of a UDDT hygienically safer than a pit latrine.

To UDDT user in areas where on-site reuse of compost and urine is feasible and applied economic benefit arises mainly from increased yields of garden and field crops.

“Benefits to the community arise from improved health and environmental protection through clean sanitation facilities and the elimination of groundwater pollution. The burden of disease in a community can therefore be reduced. Additionally, increased food production in poor communities through better availability of fertilisers improves food security and nutrition” (MÜNCH, 2009).

A further important benefit is the rise in property value and intangible benefits of dignity, privacy, security and social status. In comparison to open defecation time to find somewhere to defecate can be saved and represents a further benefit (SIJBESMA et al., 2008).

2.3.8 UDDTs in Kenya

According to GTZ (BLOH, 2009) in June 2009 there have been about 600 UDDT-units installed in Kenya. Thus 12,000 users in schools and households could be reached. A promotion project financed by EU-SIDA-GTZ (with 2.75 Mio EUR) aims at up-scaling this numbers to 1250 UDDT-units and 15,000 users in Kenya by June 2010.

2.4 Operation and maintenance of sanitation systems

This chapter begins with a short review of definitions followed by basic information on the sustainability of operation and maintenance (O&M) services, leading to community-based O&M services and ending with facts on the willingness to pay for O&M service costs.

2.4.1 Definition

The following definitions are taken from BRIKKÉ (2000).

Operation

“Operation deals with the actual running of a service (e.g. provision of fuel, starting or handling of pumps, control of water collection points, general mechanical or water treatment procedures, hygienic handling, etc.)”.

Maintenance

“Maintenance deals with the activities that keep the system in proper working condition, including management, cost recovery, repairs and preventive maintenance.

- Crisis maintenance: maintenance undertaken only in response to breakdowns and/ or public complaints, leading to poor service level, high O&M costs, faster wear and tear of equipment, and user’s dissatisfaction.
- Preventive maintenance: maintenance activities undertaken in response to pre-scheduled systematic inspection, repair and replacement, leading to continuity in service level, O&M costs spread over time, extension of life-span of equipment, user’s satisfaction and willingness to pay”.

Management

“Management deals with the control and organization of a service and encompasses the following main functions:

- Development of a vision and strategy
- Planning
- Organization and mobilization of resources
- Administration
- Accounting
- Leadership, motivation of personnel
- Supervision, monitoring and evaluation
- Promotion of external relationships”.

2.4.2 Sustainability of O&M services

It has been recognised that sustainability of sanitation infrastructure depends to a large extent on effective and efficient operation and maintenance. Thus in sustainable sanitation projects operation and maintenance (O&M) should be integrated into project development from the beginning (including the planning and construction phase). Furthermore it is of particular importance that roles and responsibilities of actors involved in O&M are well defined, especially where the traditional role of governments as a services provider shifts to that of a facilitator of service provision (BRIKKÉ and BREDERO, 2003). According to KNAPP et al. (2001) decentralised ecological sanitation systems require professional O&M and a public supervision structure based on proper legislation, since safeguarding public health lies within the responsibility of the public authorities (Figure 12).

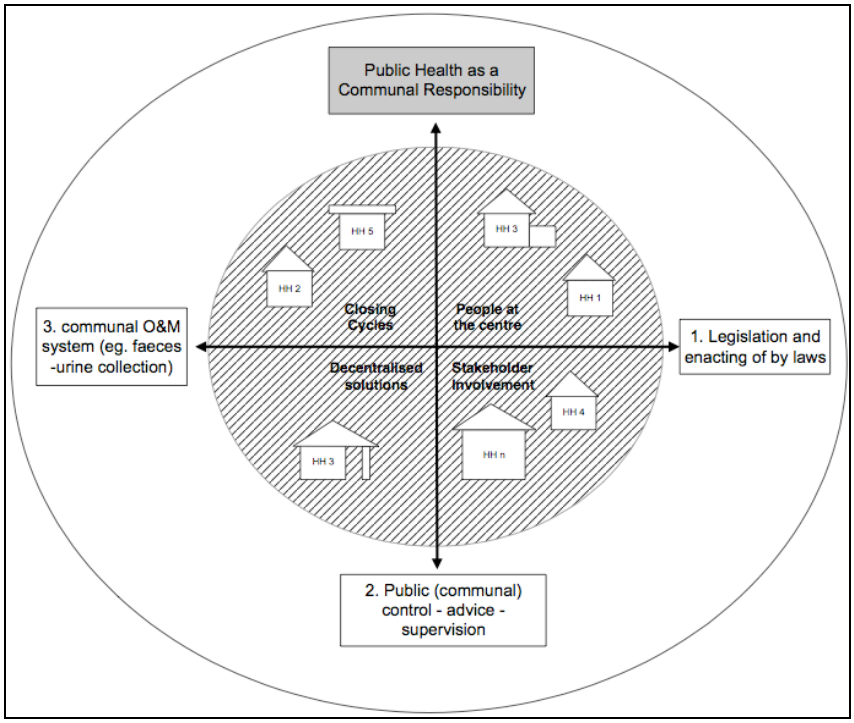

Figure 12 Responsibilities in decentralised ecological sanitation systems (KNAPP et al., 2001)

Moreover BRIKKÉ and BREDERO (2003) point out that O&M is not simply a technical issue but encompasses social, gender, economic, cultural, institutional, political, managerial and environmental aspects.

According to the WHO and the IRC **a service is sustainable when**:

- "It functions properly and is used.
- It provides the services for which it was planned, including: delivering the required quantity and quality of water; providing easy access to the service; providing service continuity and reliability; providing health and economic benefits; and in the case of sanitation, providing adequate sanitation access.
- It functions over a prolonged period of time, according to the designed life-cycle of the equipment.
- The management of the service involves the community (or the community itself manages the system); adopts a perspective that is sensitive to gender issues; establishes partnerships with local authorities; and involves the private sector as required.
- Its operation, maintenance, rehabilitation, replacement and administrative costs are covered at local level through user fees, or through alternative sustainable financial mechanisms.
- It can be operated and maintained at the local level with limited, but feasible, external support (e.g. technical assistance, training and monitoring).
- It has no harmful effects on the environment." (WHO and IRC, 2000 in BRIKKÉ and BREDERO, 2003, p. 2)

Processes focus on the approach and the methodology of working and have therefore an impact on sustainable O&M. Among those **processes, which influence the sustainability** are the following (BRIKKÉ, 2000):

- Demand from the communities;
- Responsiveness from supporting institutions and agencies;

- Participation of communities (men and women) through the whole project cycle;
- Linking technology choice with operation and maintenance;
- Integration of water, sanitation, health and environment;
- Planning with a gender perspective;
- Effective decentralization and transfer of responsibilities and resources;
- Communication among all stakeholders;
- Public-private partnership;
- Co-responsibility between community and municipality;
- Capacity-building at all levels.

Additionally SOHAIL et al. (2005) recommend the following for the **developing of sustainable O&M of urban services**:

- "Partnerships; Developing a partnerships between communities and service providers to co-manage the O&M of urban services depends on a number of factors including the community awareness of O&M issues, extent of user care for facilities, local capacity for action, presence of intermediaries between service providers and users such as local action groups or local elected political representatives, the commitment and responsiveness of service providers, mechanisms for reporting problems and participatory information gathering (such as user satisfaction surveys) amongst other aspects.
- Roles and responsibilities. Stakeholders' roles and responsibilities in performing and financing key tasks in the operation and maintenance need to be clarified: There might be a need to formalise these activities in the form of a Memorandum of Understanding. Attention should also be paid to how households/ community leaders/ NGOs/ politicians will become aware of their role.
- O&M Plans. Develop a community or municipal management plan which sets out O&M procedures, rather than O&M being a simple reaction to breakdowns in systems or complaints because of lack of staff, skills, funds etc.
- Attitudes to O&M. O&M should be viewed as critical to the sustainability of systems as well as an integral part of the planning process for the medium- and long-term. Thus staff/ communities should be trained, regular maintenance scheduled in plans, co-ordination among sectors, user education and sufficient resources allocated in budgets or collected through revenue. Staff must be provided with incentives to perform O&M and trained in the latest knowledge, skills, attitudes and documentation of systems.
- Setting out effective monitoring and evaluation systems. A reporting/information system should be set up for expenditure, use of resources, monitoring of staff and technical and progress reports. Performance can be evaluated (either by civil society groups or by service providers themselves) in terms of user opinions, and the use of personnel, resources and finances to meet the required level of service, establish performance targets; and to assess what functions are missing in O&M. Key information for such tasks includes database of plans, completed works, technical reports and the age and functioning of systems, book-keeping systems, work logbooks, stock registers and contract files.
- Improved Governance; Community linkages can strengthened by increasing the opportunities for citizens to access service providers and local government. This can be done through consultations, user surveys, frequent joint meetings to involve the community in planning O&M and monitoring; such feedback would ensure that services are meeting their objectives and that governance is improved within the city" (SOHAIL et al., 2005, p. 27).

2.4.3 Community-based O&M services

A study on community involvement in service delivery in developing countries (India, Pakistan, Sri Lanka) by SOHAIL et al. (2005) revealed that involvement of community-based organisations (CBOs) in service provision was successful, where responsibilities were clearly defined and formulated in conjunction with municipalities. CBOs with a formal legal and permanent status and a permanent source of finance were shown to be more capable of negotiating with municipalities and more sustainable and accountable in their operation. These institutions have further advantages if they have strong leadership and support from the community. Further attention should be paid to women's participation in CBOs and O&M activities. SOHAIL et al. (2005) summarise the crucial points in this respect as follows:

- „Those setting up urban services (municipalities, planners, NGOs and so on) should involve communities at the planning stage and should define roles and responsibilities, so that these institutions complement each other rather than compete;
- Municipalities or alternative service providers should develop guidelines for the execution of these tasks in conjunction with local communities.
- Municipalities must be accountable and responsive to communities' demands/ problems, particularly those of low-income communities.
- There should be a dialogue taking place between the municipality and users; and
- Community institutions may lobby to de-link land tenure and the provision of services, so that those squatting on municipal land can also receive urban services from municipalities" (SOHAIL et al., 2005, p. 14).

Generally it is important that technology is appropriate to the socio-economic and technical context, to enable maintenance with the available skills, locally available spares, etc. If technical skills, required to carry out the necessary operation and maintenance tasks, are not present within the community, municipalities or NGOs can develop them (SOHAIL et al., 2005).

A study conducted within the ROSA project Arba Minch, Ethiopia (SCHUBERT, 2008) regarding the relevance of CBO's in ecosan projects revealed that income-generating organisations are motivated to operate ecosan-options as long as they can improve the economic situation of their organization and themselves. This results from their open attitude towards innovative concepts, products or working procedures. Partially the organizations can work as a multiplier, since they can demonstrate their work to other enterprises. Furthermore they can contribute to establish new products and concepts in the community and for their own economic advantage; they can advertise the products and services to find costumers or users. When starting a new resources-oriented sanitation project existing income-generating organizations should therefore be consulted to determine their willingness to carry out special tasks of the resources-oriented sanitation concept. If these possibilities are found, they should be supported in the starting phase with training and advertisement of the new product or service in order to operate sustainable.

The main benefit of community involvement in comparison to subordinated service providers is the creation of local employment opportunities whereby income remains within the community.

2.4.4 Willingness to pay to cover O&M costs

As stated above an O&M service can only be regarded as sustainable if it is independent of subsidies. Therefore O&M costs need to be recovered from the users. However, the users need to be both able and willing to pay for the services. In this respect it is important to consider that people should not have to pay more than 3 %–5 % of their income for water and sanitation services. Given that users can afford to meet the O&M costs their willingness to pay depends on people's awareness of health, social and economic benefits of improved services. According to BRIKKÉ and BREDERO (2003) users will want to weigh the cost of an improved service against the following factors:

- "Income;
- Service level;
- Quality of service;
- Perceived benefits;
- Opportunity costs;
- Acceptability of the existing source;
- Community cohesion;
- Policy environment;
- Perception of ownership and responsibility;
- Institutional framework".

SOHAIL et al. (2005) points out that typically households are not willing to pay for sanitation service since they assume that O&M lies in the responsibility of the municipality. However households can recognize the benefits of O&M if effective health education programs are implemented. The case studies analysed by SOHAIL et al. (2005) showed that resident's willingness to pay increased if they had a voice in decisions regarding those services.

2.5 Sanitation as a business - private sector involvement

Different examples can be found worldwide where sanitation is regarded as an income generating business. Sanitation as a business is however a relatively new approach in development cooperation. The general aim is to support local sanitation-service-businesses instead of implementing toilets. Those businesses primarily offer a high quality O&M service of toilets besides the construction of them.

The given support - coming from local governments and NGOs – should be in form of demand creation (for toilets, compost and urine re-use in the case of UDDTs) through awareness-rising campaigns and hygiene education. Furthermore, micro-loan systems are needed in order to cover the investment costs of a toilet and the research and development can be supported. In the long run the sanitation businesses should be operating profitable without any external subsidises. Since this approach is relatively new the long term success could neither be proven nor could possible emerging difficulties be identified.

The Asian Development Bank (ADB, 2009) points out that the private sector is prepared to get involved. However, risks have to be manageable by the private sector and this requires a good regulatory framework that provides them with incentives. Given the presence of various financing sources, the key issues are affordability of, and access to, these sources and developing viable projects, which rely on available funds for operations and maintenance. Furthermore the ADB emphasises that private sector initiatives should be complemented by government efforts to improve sanitation. CHIPLUNKAR (2009 in ADB, 2009) highlights the need for a business plan and the recovery of costs to sustain facilities.

Possible business opportunities of the private sector or community-based organisations are:

- Construction of toilets,
- Delivery and installation of toilets,
- Preventive and crisis maintenance (repairing broken parts of the toilet, etc.),
- Maintenance and operation of public toilets,
- Collection and transportation of excreta,
- Secondary treatment of excreta (composting, biogas production, etc.),
- Reuse and sale of recycled excreta (e.g. compost),

- Building and operating of biogas converter.

In the following chapters two different sanitation programs in developing countries will shortly be presented.

2.5.1 "Sanitation as a business"-programme, Malawi

The following information is taken from the paper "Sanitation as a Business: A new spin on the challenge of sanitation Operation and Maintenance" (BRAMLY and BREALIN, 2010).

The "Sanitation as a Business"-programme by the Water for People organisation started in November 2009 in Malawi. It tries to develop an ongoing relationship between entrepreneurs and households in order to expand sanitation coverage. The following two options could be identified:

1. Using latrines as a tool to access composted faeces and urine, which has market value and can be a source of finance for entrepreneurs. At scale, compost can be sold to large-scale entities such as large-scale commercial farms and commercial fertilizer companies. The incentive is to get more customers producing compost, which means more families using latrines
2. Establishing desludging services so that families receive a toilet and have to pay businesses to regularly clean these toilets. The key is the desludging business and the fees earned from those services. The toilets are simply a means to that end, but the end result is, again, greater and sustained coverage as all people are potential customers rather than one-off beneficiaries of toilets

This particular "sanitation as a business" model is based on the assumption that composted human faeces and urine are valuable and sellable commodities, and that the entrepreneur regards an increase in profits as an incentive to extend services to new households.

The concept (Figure 13) starts with households purchasing composting toilets on loan from the sanitation entrepreneur (they don't receive cash but the installation of the toilet). The sanitation entrepreneur organizes collection and transportation of the compost from the latrines, after it is safe to handle, as repayment on the loan. Than the sanitation entrepreneur sells the compost to a local fertilizer buyer or farmer and thereby makes a profit, which pays for the investment in households as well as supports operating costs. With each collection of compost, the household works down its debt to the sanitation entrepreneur. Once the latrine is fully paid for, the household continues its relationship with the sanitation entrepreneur and, most importantly, receives a small payment for their compost, thereby encouraging the household to continue to use the latrine appropriately. The sanitation entrepreneur wants to attract large-scale compost buyers and thus needs to find new customers, i.e. to build new toilets on a loan basis as described above.

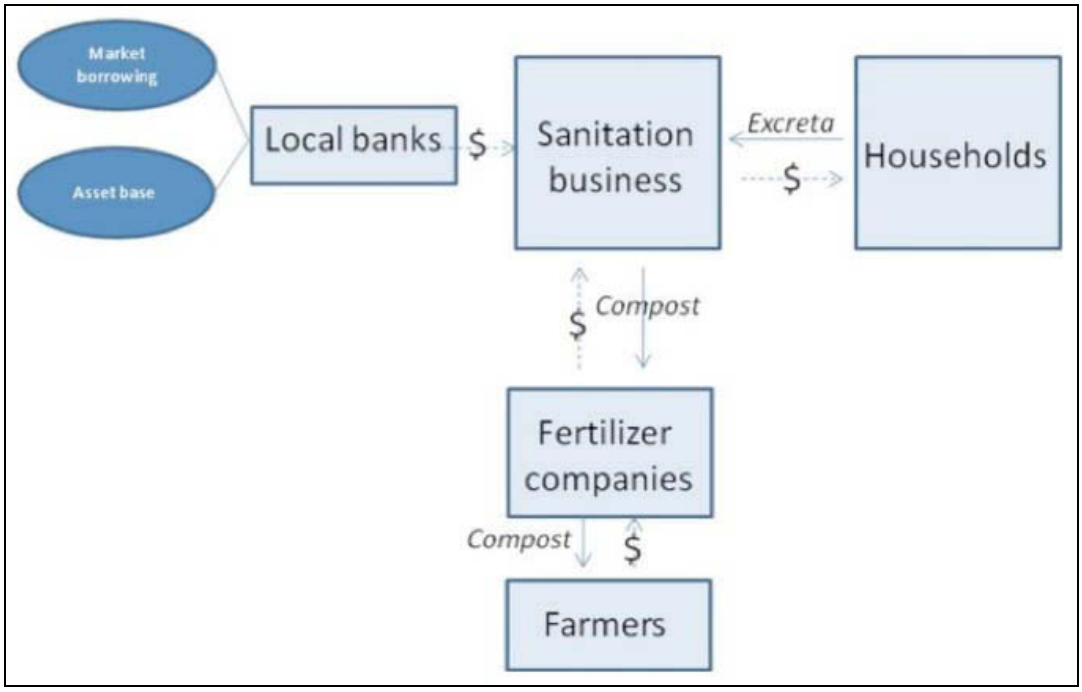

Figure 13 "Sanitation as a business" - model in Malawi (BRAMLEY and BREALIN, 2010)

Compost Marketing

In order to support sanitation entrepreneurs in building a market for 50-kg bags of fertilizer (at a price that will sustain sanitation businesses) Water for People is engaged in the following:

1. Chemical analysis of compost.
2. Development of a series of demonstration plots that show that human compost is more effective for agricultural production than commercial fertilizers
3. Development of advertising campaigns and marketing to promote the compost as a valuable product. The goal is to demonstrate that the compost is a viable but cheaper alternative to commercial fertilizers.
4. Experiments with chemical additives and animal fertilizers to increase the nutrient content of toilet compost, and thus make it more valuable.

2.5.2 "Community-Led Total Sanitation", Bangladesh

In Bangladesh different institutions and actors have developed an effective method, which led to a national sanitation coverage increase from 15 % in the early 1990s to over 50 % in 2008. The new concept called "Total Sanitation" is explained in detail by HEIERLI and FRIAS (2007). If not stated differently all information is taken from HEIERLI and FRIAS (2007).

Even though the following strategies are about marketing and private sector involvement the ultimate goal of "Total Sanitation" is to reduce the incidence of diarrhoeal diseases and child mortality. "Total Sanitation" consists of a mixture of three elements:

1) *„Creation of demand for sanitation;*
2) *The adequate supply by the private sector as an answer to this demand creation;*
3) *Social pressure to ban open defecation and thus reinforcing the demand creation further".*

Thus the approach can be considered as a combination of: a) sanitation marketing (elements 1 and 2) and b) social pressure.

a) Sanitation Marketing

1. Stimulating demand

Conclusions of the development in Bangladesh can be summarised as follows:

Stimulating demand, by good sanitation marketing strategies to awaken the desire for a hygienic environment and a toilet, has been identified as an important task of NGOs and the government.

Thus massive policy changes are required to pursue a demand-driven approach; “80 % of the public budget should be invested into promotional activities, demand creation for hygiene and awareness for total sanitation, and only 20 % should be spent on subsidies, strictly targeted to those hard-core poor who really cannot afford the hardware.” (ROY, (n/a) in HEIERLI and FRIAS, 2007, p. 25) School sanitation and public latrines at markets, etc. should also receive heavy public investments.

Advertising desirable behaviour can be done through hygiene education, sanitation campaigns in schools, raising awareness of mothers and children, with village and religious leaders and others such as politicians. However, only massive campaigns with full social, economic and political commitment (if everyone talks about it) can achieve a critical amount of attention in order to make social change happen and creating a market for sanitation.

A study on the motivational priorities to acquire a toilet in Bangladesh (ALLEN, 2003 in HEIERLI and FRIAS, 2007) has shown that prestige, convenience and privacy rank above health factors. The International Development Enterprises discovered as well that „people did not react to conventional top-down health education messages, but that the status and convenience of a latrine held a far stronger appeal for customers than did disease prevention“. Figure 14 illustrates the motivational factors that should be considered in marketing sanitation.

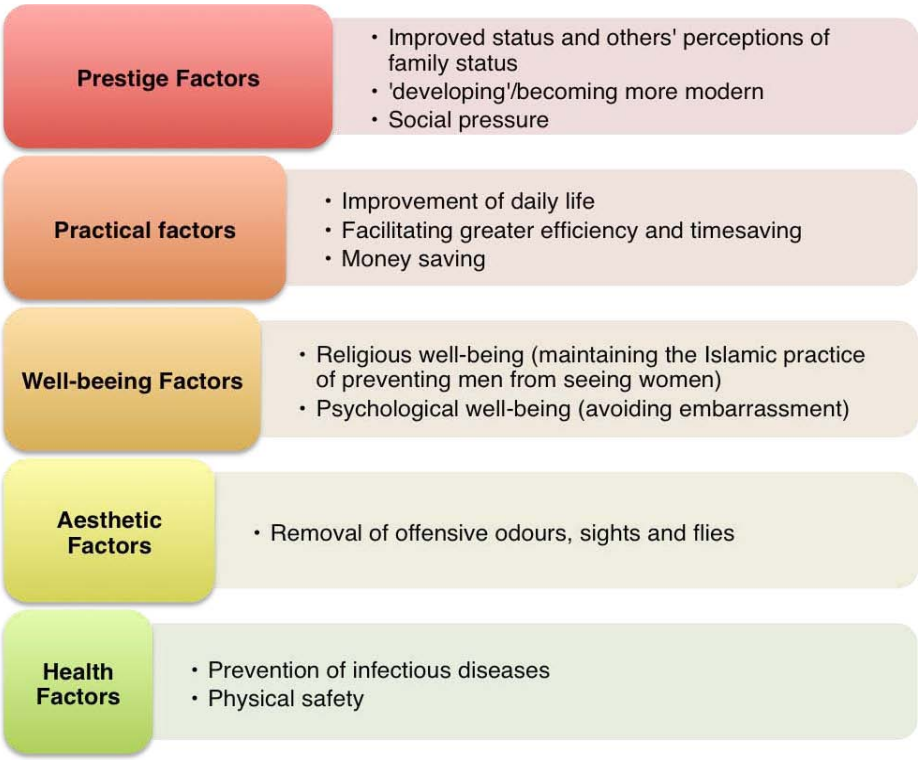

Figure 14 Priorities of motivational factors to acquire a latrine (Adopted from ALLEN, 2003 in HEIERLI and FRIAS, 2007)

Marketing sanitation should accordingly primarily emphasise practical, well-being and aesthetical factors. Whereas „prestige is not an individual, but a social factor, and is thus much more powerful“ (HEIERLI and FRIAS, 2007, p. 22) and is therefore the most important driver for toilet demand.

2. Private sector

The creation, stimulation and support of a dynamic and thriving private sector is the second element of the “Total Sanitation” approach. Results of the private sector involvement in Bangladesh are the following:

As top priority, not only a toilet as hardware, but efficient services to install and maintain them should be provided.

Furthermore it is important that toilet users are considered as customers who make their own choices according to their own preferences.

Affordability is the most crucial factor of marketing sanitation to a low-income society, thus different toilet- models are needed.

Most of the created businesses (producing and selling toilets) in Bangladesh are small-scale, informal sector industries, with relatively little capital (between USD 250 and USD 300). Their activity is highly seasonal and they do not have any marketing policy. They are therefore not in a position to advertise their products through the medium of billboards, posters or mass media; and it is even less possible that these enterprises contribute to hygiene education.

Although most of the small-scale businesses have very little working capital, a study by the Swiss Agency for Development and Cooperation (1992 in HEIERLI and FRIAS, 2007) concluded that the best way to support them is through:

1. demand creation,
2. training and
3. continued research and development, in order to allow them to produce better and cheaper products to meet the varied needs of large groups of customers.

b) Social pressure

The third element of the Total Sanitation approach "*Social pressure to ban open defecation*" was developed by the small NGO, VERC. It becomes the driving force for success if the two other elements, described above, are in place.

The attempt to ban open defecation was supported by the civil society, but to a great extent, also supported by the central and the local governments in Bangladesh. The social pressure to change the behaviour and totally ban the practice of open defecation, even against prevailing social norms and cultures, comes from the awareness of the people themselves. This "awakening" has led to a tremendous demand in toilets. Thus “Total Sanitation” is not only defined by amount of sanitation coverage, it is defined as "no more open defecation in the entire village" and by a series of hygienic behavioural attitudes, including washing hands with soap or ash before eating and after toilet use. With participatory measures, entire communities have been motivated to change their behavioural attitudes, to ban open defecation and to ensure that all people in the village – including the landless, the school children, and even visitors (in markets) – use sanitary latrines“.

The same type of social pressure may not work in other cultures therefore considerable cultural adaptation is needed.

2.6 Sanitation as a social business

The Idea of social business was publicised by M. Yunus, the founder of the first micro-credit bank and Nobel Peace Price laureate 2006. In his book “Creating a World Without Poverty” (YUNUS, 2008) he did not invent social businesses; rather he took up and elaborated the concept to present an alternative to exclusively profit-oriented businesses. Primarily YUNNUS (2006) assumes that entrepreneurs are not one-dimensional human beings, who are dedicated to only one mission - maximize profit. In fact this conceptual restrictions imposed on the players in the market, insulates the entrepreneurs from all political, emotional, social, spiritual, environmental dimensions of their lives. In his Nobel Peace Prize Lecture, YUNUS (2006) argued that “by defining "entrepreneur" in a broader way we can change the character of capitalism radically, and solve many of the unresolved social and economic problems within the scope of the free market. Let’s imagine an entrepreneur who, instead of having a single source of motivation, now has two sources of motivation, which are mutually exclusive, but equally compelling − a) maximization of profit and b) doing good to people and the world. Each type of motivation will lead to a separate kind of business. Let us call the first type of business a profit-maximising business, and the second type of business as a social business.” Moreover YUNUS (2006) sees the potential of social business in changing “the lives of the bottom 60 per cent of world population and help them to get out of poverty”.

The main principles of a social business are defined as follows (YUNUS, 2008):

- It aims at solving social and environmental problems to overcome poverty; not profit maximisation.
    - e.g.: high-quality food at very low prices, health insurance for the poor
- It is in every respect a economic-business - financial and economic sustainable;
- Invested capital are repaid after time without dividend payment;
- Profits are reinvested into the business for expansion and improvement;
    - Leads to: lower prices, better service, easier access
- Workforce gets market wage with better working conditions.

YUNUS (2010) distinguish between two types of social businesses:

1. “Type I: focuses on businesses dealing with social objectives only. (E.g. the product produced is for the benefit of the poor.)
2. Type II: can take up any profitable business so long as it is owned by the poor and the disadvantaged, who can gain through receiving direct dividends or by some indirect benefits. (E.g. the product could be produced by the poor but exported to an international market while net profits would go towards workers benefits.)”

These two types can be mixed together in the same social business, like in the case of Grameen Bank, which is owned by the poor and pursues only social objectives.

One of the pioneering social business (type I) is the „Grameen Danone Company“ a joint venture of “Grameen Bank” and “Groupe Danone”, which aims at improving the malnutrition of children in Bangladesh by selling enriched yoghurts to a very low, affordable price (YUNUS, 2008).

Meanwhile global networks exist that award and support social businesses. The first award winning social entrepreneur in Sub-Saharan Africa is Mr. Kuria the Co-founder of Ecotact in Kenya, who won the Schwab Foundation’s Africa Social Entrepreneur of the Year Award for 2009 (ECOTACT, 2010). Known under the name “Ikotoilet” this social business is presented in the next chapter.

2.6.1 "Ikotoilet", Kenya

Ecotact is one example of a social business designed to improve the current lack of sanitation in Africa. Ecotact launched the Ikotoilet initiatives in 2008 and invested USD 1.2 Million in construction of 40 sanitation facilities in 12 municipalities in Kenya. It serves an average of 300,000 people daily with safe water and sanitation and created a pool of 100 employees. Ikotoilets are „toilet malls" which combine different micro enterprises (e.g. shoe shine services, barber shop, newspaper vendor). The project is a private/public partnership between Ecotact Ltd and respective local authority (which provide public land) and water and sewerage utilities. The term Ikotoilet is derived from ecological sanitation whereby "Iko" is also a Swahili word depicting existing. The operational and maintenance costs of the facilities are covered by small user-fees (5 KES per use).

Based on the ecological sanitation concept it strives to achieve the following objectives (ECOTACT, 2010):

- „Providing convenient, highly hygienic and sustainable water and sanitation services to urban centres;
- Creating employment opportunities for youth;
- Conserving diminishing natural resources as well as conserving public health;
- Influencing a policy shift in the governance of municipalities in relation to the provision of water and sanitation services;
- Transforming, restoring and ensuring sustainability of social dignity in the growing urban populations;
- And revolutionizing people's perceptions towards toilets as well as environmental and sanitation awareness".

Ikotoilet sanitation facilities make use of a waterless dry toilet system facility for urine recovery, hence collecting at present an average of 400,000 litres of urine per month. It is planned to convert this into urea to be sold as fertilizer (see chapter 2.3.3.) (ECOTACT, 2010).

3. Conceptual Framework and Hypotheses

3.1 The ROSA project

The project "Resource Oriented Sanitation concepts for peri-urban areas in Africa" (ROSA) is an EU funded project that promotes resource–oriented concepts as a route to sustainable sanitation. The project started in October 2006 and ended in March 2010. Resources-oriented sanitation concepts have been applied in four pilot cities in Eastern Africa, namely, Arba Minch (Ethiopia); Nakuru (Kenya); Arusha (Tanzania) and Kitgum (Uganda). In these cities the local project consortium comprises the municipality administration and a local university supported by 3 European universities and two NGOs. (List of the involved partners in appendix 9)

The objectives of the ROSA project can be summarized as follows:

- to promote resources-oriented sanitation concepts as a route towards sustainable sanitation,
- to implement resource-oriented sanitation concepts in four model cities in East Africa,
- to research the gaps for the implementation of resources-oriented sanitation concepts in peri-urban areas, and
- to develop a generally applicable adaptable framework for the development of strategic sanitation and waste plans.

The achievements of the ROSA project are different in every country and for the purpose of this thesis the following chapter will present the results in Nakuru, Kenya, only. More information on the ROSA project can be obtained from Langergraber et al. (2010).

3.2 Area of research

3.2.1 Kenya

Kenya is situated at the equator on the East Coast of Africa (Figure 15). It has gained independence from British colonization in 1963. Despite good economic growth in recent years, 50 % of Kenyans live below the poverty line (CIA FACTBOOK, 2010).

Figure 15 Map of Kenya (OXFORD CARTOGRAPHERS, 2011)

The tribe one belongs to is still one of the main facts of social life. The Kikuyu tribe is the biggest and dominates the country politically and economically. The first president Kenyatta was a Kikuyu, as well as the current President Kibaki. The Worldwide Corruption Perceptions ranking of countries published by Transparency International in 2009 indicates the high level of corruption in Kenya: Rank 146 out of 180 (a lower rank means more perceived corruption) (TRANSPARENCY INTERNATIONAL, 2009). The Fischer World Almanac 2010 published the following key data about Kenya (Table 4).

Table 4 Basic data about Kenya (FOCHLER-HAUKE, 2009)

Area	580,367 km²
Population (2007)	37 million
Population growth rate (1990 to 2007)	2,8 %
Access to sanitation facilities (2006)	42 %
Access to drinking water (2006)	57 %
Human Development Index Rank (2008) (out of 184)	144
GDP (nominal) per capita (2007)	640 USD
Urban Population	21 %
Life expectancy	54 years
Infants mortality rate (under one year old per 1,000 live births) (UNICEF 2008)	81

The urban poor in Kenya do not have adequate access to basic infrastructure services, such as electricity, water, sanitation, housing, or household waste collection. Local authorities have the mandated to provide some or all of these services, but often fail to do so, especially for the poorest residents.

3.2.1.1 Sanitation and Water supply

Kenya is classified as a chronically water-scarce country. According to WHO and UNICEF (2010) only 27 % of the urban population has access to improved sanitation (Figure 16) and 51 % of the urban population uses shared facilities in 2008. In urban areas 17 % of the population use an unimproved source of drinking water.

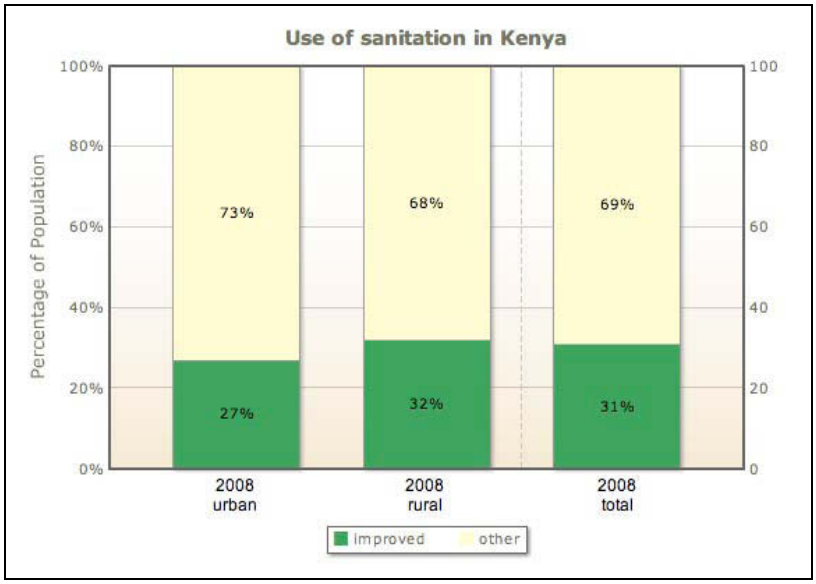

Figure 16 Use of sanitation in Kenya (WHO and UNICEF, 2010)

The Government launched a „2007-2015 National Water Services Strategy“ (NWSS) that aims at increasing access to improved, safe sanitation to 77.5 % for urban residents and 72.5 % for the rural population. The NWSS realised that such an increase cannot be achieved by conventional sewerage systems, particularly as the recycling of effluent is critical. Therefore NWSS promotes resources-oriented sanitation options wherever this concept is acceptable to communities (ONYANGO and ODHIAMBO, 2009)

3.2.1.2 Institutional Structure of the Sanitation Sector

„The national regulator, the Water Services Regulatory Board (WSRB), has been created by virtue of the 2002 Water Act to supervise water services provision in the country. However, some regulatory tasks are delegated to the seven regional Water Service Boards (WSBs). A Water Appeals Board (WAB) is responsible for resolving and determining certain disputes. The Water Services Trust Fund (WSTF) assists in financing the provision of water to unserved areas without adequate supply“ (GTZ, 2006). The institutional structure of the sanitation sector is illustrated in Figure 17. The WSBs have registered about 118 Water service providers (WSPs) until 2009 (WASREB, 2009).

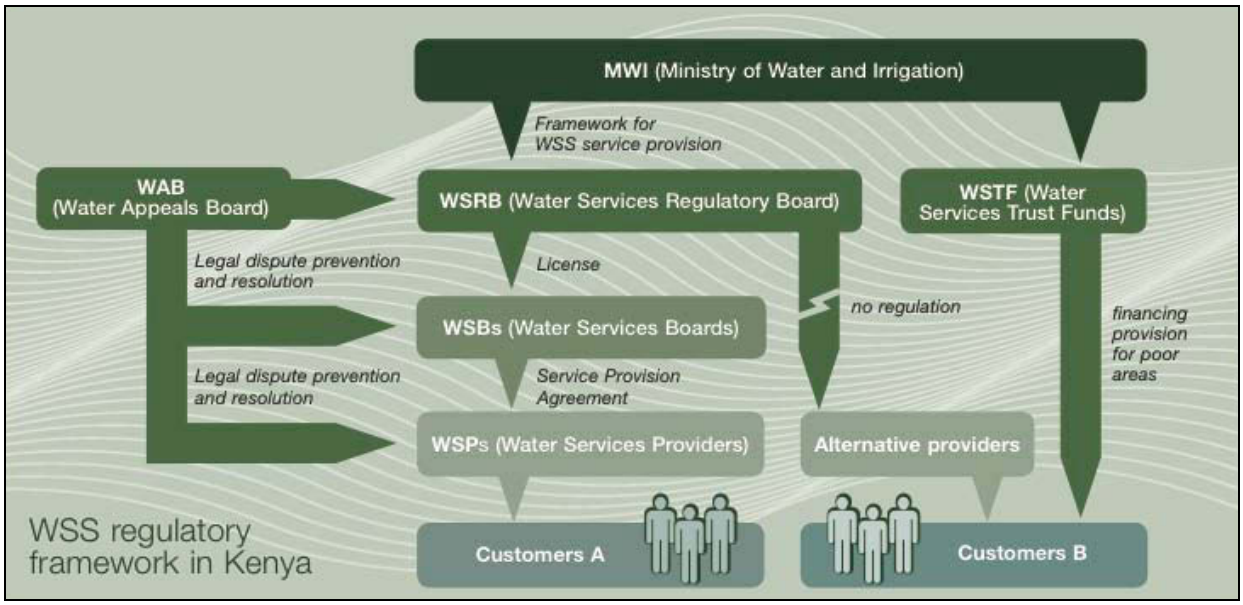

Figure 17 Institutional structure (GTZ, 2006)

The Water Service Regulatory Board published "A performance Report of Kenya's Water Services Sub-Sector" in 2009 wherein in following statements can be found (WASREB, 2009):

- „Poor management continues to be an issue at the level of WSPs. It is manifested in poor delegation of powers and responsibilities, insider lending, problems of un-surrendered or unaccounted for imprest, poor and opaque cost control, opaque tendering procedures, and resistance to change."
- "Most institutions in the sector have directors that have no knowledge of the sector, which situation has resulted in poor management of the institutions with regression or stagnation in performance. There is need to amend the Water Act 2002 to ensure appointment of Directors with defined qualifications, who should also be representative of all the stakeholders."
- "The budget allocated by the Ministry of Water and Irrigation to water supply and sanitation is largely not adequate."

In this report it is stated that Nakuru has water supply coverage of 66.7 % compared to a national average of 36,9 percent. Whereby water coverage describes the population served by a WSP compared to the population living within the service area of the WSP. The water service providers in Nakuru have a total number of 25,961 water connections. Furthermore it reveals that Nakuru has sanitation coverage of 96 per cent. Whereby sanitation coverage is defined as: "the proportion of the population within the service area of the WSP which is using improved sanitation facilities. These are defined as flush or pour-flush to piped system, septic tanks, ventilated improved pit latrines and pit latrines" (WASREB, 2009, p.22). The national average sanitation coverage has been estimated at 49.5 per cent. Anomalies, like the 96 % sanitation coverage in Nakuru, are explained with the fact that „most WSPs do not manage on-site sanitation and therefore they do not have information on the same. Owing to this, data captured in this section is unrealistic and therefore may not be reliable" (WASREB, 2009). This presents the poor performance of the WSPs and reflects the neglected situation of unserved peri-urban areas or informal settlements in Nakuru.

The Local Government Act Cap. 265 establishes local authorities in the republic of Kenya and mandates them to manage development and provide sanitation services in areas of their jurisdiction (MCN, 2010).

3.2.2 Nakuru

The information in this chapter is mainly taken from a Nakuru Baseline Study (ROSA NAKURU TEAM, 2007) if not stated differently.

Nakuru is the forth-largest town in Kenya, located 160km North West of the capital city Nairobi next to Lake Nakuru National Park. The town covers an area of 102 km² with approximately 500,000 inhabitants and a considerable annual population growth rate of seven per cent. It is surrounded by rich agricultural hinterland and represents a central transport hub since it is the capital of the Rift Valley province.

Poverty in Nakuru is widespread and is caused mainly by unemployment, landlessness, lack of water and other basic services such as education, social services and credit facilities.

The climate is semi-arid and characterized by two rain seasons. An average rainfall of 800-900 mm per year and an average temperature of 24 to 29°C are recorded across the town. The soil is mainly volcanic loose soil and the town is characterized by young volcanic rocks and localized faulting. According to OTIENO (2005 in ROSA NAKURU TEAM, 2007) the water table ranges between 60 and 130 m depth.

3.2.2.1 Water supply

Water supply is one of the major problems in Nakuru, especially in the low-income areas. MUCHUKURI and GRENIE (2009) estimated that more than 50 per cent of town residents do not have adequate water supply (in comparison to the 33 per cent stated by the WSPs above).

There are areas in the town where water is scheduled at specific hours each day while other areas receive water twice a week or are only sporadically provided with water. Access to water and frequency of water supply in Nakuru town is presented in Figure 18. Rationing highly affects the low-income areas due to the low number of access points and lack of storage facilities.

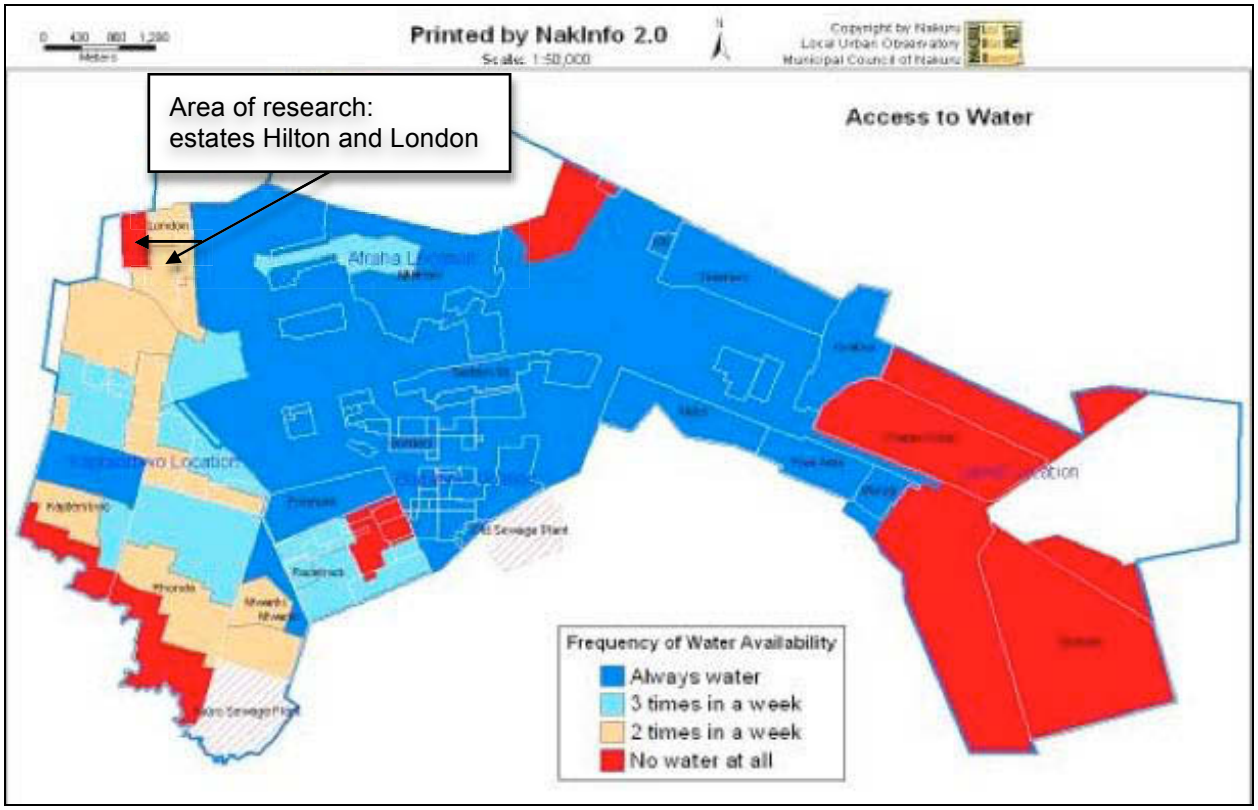

Figure 18 Accesses to Water and Frequency of Water Supply in Nakuru Town (LUO Project (2007) in ROSA NAKURU TEAM, 2007)

The town receives water from both surface and groundwater sources. Other water sources include private vendors, wells and rainwater catchment. Water supply in peri-urban areas is mainly organized by private initiatives such as water vendors who are the main alternative source of water. There are three water kiosks in operation, which are managed by local community based organisations and run by volunteers. The water is currently sold at 10 KES for a 20 litre container. The average water consumption per household lies at 65 l/d per capita.

3.2.2.2 Sanitation

In Nakuru 19 % of the urbanised area is served by a sewer system (only in middle and high income areas) which is connected to two waste stabilization ponds with a total installed capacity of 16 200 m3/day (utilised capacity: 50 %). In areas without a sewer connection many residents rely on cesspools and septic tanks, available mainly in high-income areas, while the majority either have access to shared pit latrines or dispose of their waste openly (MUCHUKURI and GRENIE, 2009). Pit latrines causes problems especially in the densely populated peri-urban areas where they fill up frequently and require emptying or digging new pits every few years. Furthermore these systems cannot be used effectively in areas with rocky ground or on loose sandy soils since they often collapse during flooding and emptying. In densely populated areas it is also common that one toilet is shared by 15 or more people especially in rented houses with toilets in the yard (OTIENO, 2005, in ROSA NAKURU TEAM, 2007). Furthermore there is one public toilet managed by the Municipal Council of Nakuru and three by a CBO, which charges KES 5 for normal usage and KES 20 for showering and laundry services.

Water and sanitation related diseases have been and continue to be among the top ten diseases that cause highest morbidity within the district. They include diarrhoea, intestinal

worms, skin diseases and malaria. The high incidences in particular of diarrhoeal and skin diseases are largely caused by inadequate safe water and inadequate water supplies coupled with poor hygiene standards. Diarrhoeal diseases are however the leading cause of mortality in children less than five years old within the district.

3.2.2.3 Institutional framework

Under the Local Government Act the Nakuru Municipal Council was established in the early 1950's responsible for sanitation services. Recently the Municipal Council of Nakuru, involved the private sector and CBOs in collection, transportation and disposal of solid waste, recycling, composting and emptying of pit latrines. At present a total of 17 private collectors have been licensed to collect and transport solid waste from designated areas within 14 zones of operation (MCN, 2010).

Besides the national and regional institutional structure a Nakuru Environmental Consortium (NEC) has been established in Nakuru. This consortium consists of the Municipal Council of Nakuru, the Nakuru business association, representatives of the informal sector, different NGOs (amongst others Practical Action), Nakuru Water and Sanitation Services Company Limited (NAWASSCO) and the Family Bank. It aims at cleaning the city and improving the access to adequate sanitation facilities in order to protect the environment especially the lake Nakuru.

The NEC tries to involve all segments of the population in the planning of different service provisions and assess roles, responsibilities and institutional relationships of all service providers and other stakeholders in the area. Furthermore the municipality establishes public-private partnerships and informal sector operations.

3.2.2.4 Urban agriculture

According to study entitled "Urban Farmers in Nakuru, Kenya" by FOEKEN and OWUOR (2000 in ROSA NAKURU TEAM, 2007) 75 % of households in Nakuru practise farming. Most people cultivate the common food crops, mostly for their own consumption or for commercial purposes. Almost all crop cultivators used at least one type of fertilizer. Of the 594 households interviewed in Nakuru town, 366 (62 %) could be classified as urban dweller farming in the rural areas. BRÄUSTETTER (2007) states that farmers in the Nakuru area seem to prefer organic fertiliser to chemical fertiliser since the organic fertiliser releases the nutrients slower, which is an advantage especially in the rainy season.

3.2.2.5 Financing sanitation in low-income areas

Advantageously Nakuru has an innovative programme available to finance sanitation. Innovative approaches to finance sanitation in poor-urban areas can generally be characterised by (TREMOLÉ et al, 2007 in SIJBESMA et al., 2008):

- "low-income groups having information about various options
- users and communities deciding for themselves
- finance schemes acknowledging the need to cover soft costs (training, advocacy, knowledge) and hard costs (infrastructure)
- the involvement of the local private sector
- the main source of finance continuing to be user fees (in order to be sustainable)
- breaking barriers to extend the service to unserved inhabitants."

As described in chapter 3.3.2 the micro-credit programme launched by the Family Bank under the Dutch ISSUE-2 programme meets those criteria.

3.3 ROSA project in Nakuru, Kenya

In the course of the project a baseline study and different surveys were conducted to identify actual local conditions, needs and preferences. Amongst others it could be determined that:

- The main responsibility for sanitation facilities lies with landlords/landladies, households and tenants.
- A majority are interested in using an UDDT if they are not responsible for operation and maintenance.
- 61 % of respondents of a survey with 215 questionnaires were willing to use urine and treated faecal matter in their gardens.
- CBOs and service providers who are currently involved in solid waste management may be interested in providing service for households with UDDTs

Due to local conditions in the implementation area like water scarcity and rocky underground structure the UDDT option has been chosen. The demonstration sites; a nursery school, one residential plot and a secondary school, are located in the two neighbouring estates Hilton and London. To visualise the estate and the residential plots a selection of photos is presented in appendix 3. The pilot installations are described in detail in the following chapter.

3.3.1 Pilot installations

The two estates, Hilton and London, which were chosen as pilot area are characterised by a lack of a sewerage system and water scarcity thus water is sold by vendors at 10 KES for 20 litres. In addition the estates feature volcanic soil, which is unfavourable for the construction of pit latrines.

Pilot 1 - Church and nursery school

The first pilot UDDT unit was constructed at a church and nursery school compound to serve the church congregation of about 50 members and a nursery school with an enrolment of 25 children and three teachers. The facility has a separate unit for men and women and consists of two single vault UDDTs, one urinal cubicle with five waterless urinal bowls and one double vault UDDT with solar drying at the back. The faeces are collected directly in the vault underneath the toilet chamber. The material is stored in 50 litres open containers. The space is enough to allow up to three 50 litre containers to fit in. Urine is collected in a 30 litres plastic container. Provision is made for discharging the excess urine through an over flow pipe into a soak away pit, with the possibility to collect the urine for a later use. Furthermore, roof water is harvested into a 250 litre tank which is connected to ceramic hand washing basins in both the male and female unit.

Pilot 2 - Residential plot

The UDDT unit consists of three stance single vaults UDDTs to serve a plot with 28 tenants. One is for female users, one for children while the third, which is also fitted with a urinal bowl, is allocated for male. The construction is similar to church toilets.

Pilot 3 - Crater View Secondary School

The facility is designed for 200 students and consists of eight single vaults UDDTs, five for girls and 3 for boys and a urinal with ten urinal bowls. Each vault holds three 50 litre containers for faecal matter. The girls section has 4 girls' urinal chambers each with a urine channel. The urine is collected and stored in a 2,000 litre underground tank. When the container is full it overflows to a soak away pit. Rainwater is harvested from the corrugated iron roof into two 250 litre plastic water tanks to provide water for hand washing.

3.3.2 Up-scaling of UDDTs with microcredit assistance

Since the beginning of 2009 construction of UDDTs by landlords in the estates can be observed. Up to the beginning of 2010 a total of 20 UDDTs, have been constructed by landlords. A micro-credit program launched by the Family Bank under the ISSUE-2 program is available to landlords to cover the investment costs, in addition to an advisory service on various sanitation technology options. So far 75 % of loan beneficiaries (15 landlords) opted for UDDTs. Figure 19 and Figure 20 show 2 of the privately installed UDDTs in a low-income peri-urban area in Nakuru.

The ROSA partner WASTE launched the ISSUE-2 initiative to enable landlords and households to invest in improved sanitation. Practical Action is the implementing partner of ISSUE-2 in Kenya. ISSUE-2 aims to reach 5,000 households in low-income peri-urban areas in Nakuru. Furthermore it supports micro, small and medium enterprises and community based waste enterprises working in the urban environment sector in Nakuru in decentralized municipal solid waste management (household level collection and safe disposal and/or material recycling) and resources-oriented sanitation with allied material recovery of organic and inorganic waste streams. Features of this micro-credit programme are (MWANZIA, 2009):

- Low annual interest rate of 9 % on reducing balance below average market rates,
- No handling fee,
- Reasonable repayment periods – minimum 24 months,
- Affordable monthly loan repayments by debiting the borrower account,
- Flexible Security - Chattels mortgage over business and household assets.

Figure 19 UDDT replication on a residential plot

Figure 20 Construction of UDDTs in progress

3.3.3 Private sector involvement

In order to close the nutrient cycle within the resources-oriented concept the ROSA team identified at least one CBO, which is willing to provide the collection, transportation and treatment of separated human excreta from UDDTs. The organisation called MEWAREMA is currently offering solid waste collection service in the same estates where UDDTs have been constructed recently and produces compost from organic market waste. The purpose of this thesis is to determine whether MEWAREMA will be able to offer these services of collection, transport and treatment profitable. The planned operation and the resources available for them

are briefly described: The collection, emptying of the faecal matter container into the donkey cart, will be done manually by two trained labourers. Transportation of faecal matter will be carried out with a donkey-cart and co-composting will sanitise the faecal matter. The co-composting plant consists of a drying shed (financed by ISSUE-2) where the faecal matter from UDDTs is dried, mixed with organic waste and co-composted (Figure 21). The 40 m² drying shed is located at a dumpsite, which borders on the two estates (Hilton and London) where at present 24 UDDTs are in operation. The produced hygienically safe compost will than be sold to the organic fertilizer cooperation NAWACOM. Further information on operational processes can be found in the business plan (chapter 5.2.2).

Figure 21 Drying shed (under construction)

Unfortunately the project ended before an O&M service could be installed in the O&M phase of the project cycle. Therefore it is questionable if the performance of the O&M service will be further monitored and evaluated to determine the potential of up-scaling this community–based O&M service approach.

3.4 Research Hypotheses

The thesis underlies three research questions (chapter: 1.3). The first research question: “How can a collection, transport and treatment service of separated human waste be offered by a community-based organisation in peri-urban estates in Nakuru?” is not expressed in form of a hypothesis, as it demands the developing of an operational concept (chapter 5.1). In this chapter the two main hypotheses are formulated and defined. The first hypothesis corresponds to the second research question whereas the second hypothesis refers to the third research question.

3.4.1 Hypothesis I

Derived from the second research question: “Can a community-based, resource-oriented human waste management system in Nakuru be operated cost-effectively?” the following first main hypothesis is framed.

H.I	The operation of a resources-oriented human waste management system is profitable.

Profit respectively operating profit is defined as: “Total revenues from operations minus total costs from operations (excluding income taxes)” (BHIMANI et al., 2008).

In this case of a community-based operation the business is regarded as profitable if an operating profit of zero is realised since the simultaneously gained no-monetary benefits, which are not accounted for in the calculation, present advantages (respectively “profit”) for the community.

Therefore the first sub-hypothesis H.I-1 refers to the generated costs and benefits whereas the benefits have to preponderate the costs. The costs are calculated using an income statement and the anticipated benefits are ascertained by consideration and comparison to data of the literature review.

H.I-1:	The cost-benefit analysis is positive.

The second sub-hypothesis H.I-2 refers to accounting. Since the breakeven point is defined as: “Quantity of output where total revenues and total costs are equal; that is where the operating profit is zero.” (BHIMANI et al., 2008) it is used to determine the potential profitability within the first five years of operation. Preconditioned that the unit selling price exceed the unit variable costs (SP - VP > 0) the break even point is calculated as follows:

$$\text{Breakeven point} = \frac{\text{Fixed Cost}}{(\text{Selling Price} - \text{Variable Cost})}$$

The second sub-hypothesis H.I-2 is:

H.I-2:	A potential profitability can be calculated by using a breakeven analysis (BEA).

The third sub-hypothesis H.I-3 results from the fact that in order to breakeven a certain number of customers needs to be available. Thus the demand of toilet facilities within the catchment area has to meet the number of toilet facilities required to break even.

H.I-3:	The demand of toilet facilities meets the number of toilet facilities required to breakeven.

In the fourth sub-hypothesis H.I-4 a further condition to breakeven is considered. The demand of compost within the Nakuru region has to correspond to the required amount of compost sold to breakeven.

H.I-4:	The demand of compost meets the amount of compost sold required to breakeven.

Table 5 summarises the sub-hypothesis, which have to be proved to verify the first main hypothesis.

Table 5 Main hypothesis I and sub-hypotheses

Hypothesis I		
H.I	The operation of a resources-oriented human waste management system is profitable.	
Sub-hypotheses		
H.I-1	The cost-benefit analysis is positive.	Benefits preponderate costs
H.I-2	A potential profitability can be calculated by using a breakeven analysis (BEA).	breakeven point = FC / (SP−VC) SP − VC > 0 FC is Fixed Cost SP is Selling Price VC is Variable Cost
H.I-3	The demand of toilet facilities meets the number of toilet facilities required to breakeven.	The result of the BEA is the number of toilets required to breakeven.
H.I-4	The demand of compost meets the amount of compost sold required to breakeven.	The result of the BEA is the amount of sold compost required to breakeven.

3.4.2 Hypothesis II

The second main hypothesis is partly based on the first main hypothesis and derived from the third research question: “Does MEWAREMA fulfil the objectives of a social business?“

The second main Hypothesis is:

H.II	MEWAREMA is a social business.

In order to verify this main hypothesis the following sub-hypothesis have been framed in accordance with the principles of a social business described in chapter 2.6.

H.II-1:	It aims at solving social and environmental problems.
H.II-2:	It is in every respect a economic-business - financial sustainable.

The long-term financial sustainability of a sanitation business is gained if operation, maintenance, rehabilitation, replacement and administrative costs are covered at local level through user fees, or through alternative sustainable financial mechanisms (WHO and IRC, 2000 in BRIKKÉ and BREDERO, 2003). This sub-hypothesis (respectively if revenues can cover operating costs) is verified with the corroboration of the first main hypothesis.

H.II-3:	Invested capital is repaid after time without dividend payment.
H.II-4	Profits are reinvested into the business for expansion and improvement.
H.II-5	Workforce gets market wage with better working conditions.

Table 6 lists the sub-hypothesis, which have to be corroborated to verify the second main hypothesis

Table 6 Main hypothesis II and sub-hypotheses

Hypothesis II		
H.II	MEWAREMA is a social business.	
Sub-hypotheses		
H.II-1	It aims to solve social and environmental problems.	
H.II-2	It is in every respect a economic-business - financial sustainable	The first hypothesis could be confirmed.
H.II-3	Invested capital is repaid after time without dividend payment.	
H.II-4	Profits are reinvested into the business for expansion and improvement.	
H.II-5	Workforce gets market wage with better working conditions.	Wages of MEWAREMA's labourer ≥ minimum wages in Nakuru; protection clothing is available and used

4. Methodology

4.1 Selection of research area

The city of Nakuru in Kenya was chosen as a case study for the research because the BOKU has a bilateral partnership with the Egerton University in Nakuru and EcoSan Club, the second Austrian ROSA partner, is the European partner responsible for operation and management. By the end of the ROSA project in Nakuru a collection, transport and treatment service has not yet been installed and further research is needed.

4.2 Selection of methodology

Various approaches have been used to collect the data related to the first research question and the two hypotheses. Depending on the accessibility of the information needed, these approaches include a literature review and a field visit of five weeks where key informants interviews, direct discussions and a UDDT-owner telephone survey (see Appendix 10) were conducted. The interview technique differed according to the interview situation, interview partners and the desired information.

The first research question is answered by a developed operational concept which integrates the supply and value chain. It presents the dependencies and value exchange between the stakeholders.

In order to verify the first hypothesis a projected income statement, included in a detailed business plan, was prepared. Due to differences in management accounting and control techniques in Anglo-Saxon and German-speaking areas calculations were made according to “MANAGEMENT AND COST ACCOUNTING” by BHIMANI et al. (2008). The business plan was developed according to “THE ERNST & YOUNG BUSINESS PLAN GUIDE” by FORD et al. (2007).

To test the second hypotheses the objectives and basic conditions of the CBO MEWAREMA, the CBO willing to carry out the collection, transport and treatment service of separated excreta from UDDTs, were analysed according to the principles of a social business defined in chapter 2.6.

4.3 Supply and value chain

According to BHIMANI et al. (2008) the terms supply and value chain are defined as follows: The supply chain “describes the flow of goods, services and information from “cradle to grave”, irrespective of whether those activities occur in the same organisation or an other.” And the value chain is “the sequence of business functions in which utility (usefulness) is added to the products or service of an organisation”. Whereby the enabling environment are regulatory structures including the support, services, institutional, legal and policy frameworks in which value chains operate (MITCHELL et al., 2009). According to FELLER et al. (2006) „value is highly conditioned by the larger social and economic environment through which complex and numerous interactions affect the human perception of value-based transactions. Advertising, social trends, and economic conditions all influence consumer and business valuations of products, services, and resources flowing through the value systems“. Information about customers demand and how customers evaluate goods and services should be gathered to steadily adopt the quality of the service.

4.4 Financial data collection

The methods used to collect financial data included a literature review and semi-structured interviews. To prepare an income statement the single elements were determined as follows:

- The cost of wages, supervisor salary, donkey food, water, maintenance cost for the donkey cart were defined in an interview with one of the leading persons of MEWAREMA.
- The fee for the service was already negotiated in a group discussion lead by the ROSA Nakuru team and was therefore only confirmed by means of a telephone survey with the UDDT-owner (see Appendix 10).
- To determine the number of UDDTs in the estate and the difference in time needed to fill one faecal matter container the same telephone survey was used (see Appendix 10). The names and telephone numbers of UDDT owner were received from Practical Action.
- The sales price of the compost has been derived from a discussion with NAWACOM the future buyer of the compost.
- To understand the mechanism of all stakeholders involved, an interview with Mr. Mwanzia (Practical Action) was conducted.

4.5 Business Plan and Projected Income statement

4.5.1 Business Plan

A business plan is a document designed to map out the course of any business (ongoing-, start up-, non-profit entity) over a specific period of time and thus analysing the business potential. It includes an annual business plan, which focus intently on the coming 12 month and giving a more general attention about the following four years. According to FORD et al. (2007) a business plan is an absolutely necessity for any business and serves three functions:

- “Determining future projects
- Determining how well goals have been met
- Raising money”

The business plan is a strategic planning document to develop ideas about how the business should be conducted by examining the company from all perspectives, such as marketing, finance and operations. Furthermore it’s a retrospective tool to assess a company’s actual performance over time. The business plan should therefore be examined on a periodic basis to see where and why the company strayed and how the business should operate in future as assumptions and projections must be constantly refined. In addition “most lenders or investors will not put money into a business without seeing a business plan” (FORD et al., 2007).

4.5.2 Projected income statement

An income statement captures in summary the profits of a prospective venture and is therefore the most common indicator of financial performance for start-up and existing ventures (FORD et al., 2007). The projection is generally divided into revenues, cost goods or services, operating costs and resulting (pre-tax) profit or loss. The income statement has to be consistent with the potential and limitations discussed in other sections of the business plan.

In order to make to calculation as realistic as possible the current UDDT owner were interviewed to determine the average fill up time of the faecal matter container. Thus allowing developing a time schedule to simulate how many faecal matter containers would have to be emptied per month. The same was done for the urine collection since some of the UDDT owners are willing to pay for the urine collection.

4.5.3 Breakeven point

In regards to MEWAREMA as a social business, the breakeven analysis provides information about the potential profitability. The breakeven analysis demonstrates the level of sales that must be attained in order to meet cash obligations. Thus the breakeven point is the quantity of output where total revenues and total cost are equal, that is, where the operating profit is zero (BHIMANI et al., 2008). The contribution margin method was used for determining the breakeven point. The procedure to calculate the breakeven point is to segregate all cash obligations into fixed or variable costs and to insert these figures in the following formula. Whereby the unit contribution margin is equal to the unit selling price minus the unit variable cost.

(Eq. 1)

$$\text{Breakeven point (in sales) [KES]} = \frac{\text{Fixed Cost [KES]}}{\text{Unit contribution margin / Unit Selling Price [KES]}}$$

The number of units i.e. the output of compost in kg can be computed using the following formula.

(Eq. 2)

$$\text{Breakeven point (No. of units) [kg]} = \frac{\text{Fixed Cost [KES]}}{\text{(Unit Selling Price – Variable Cost) [KES]}}$$

In the case study the wages of the treatment plant operator are regarded as fixed cost since their number of working days does not depend on the number of UDDTs served but on the co-composting process only. Furthermore in order to be able to calculate the breakeven point against the units (kg) of compost sold, the operating loss of the service branch (collection and transportation) was regarded as direct material cost used in the manufacturing branch (co-composting).

4.5.4 Product costs and unit costs

The product costs are the sum of the costs assigned to a product for a specific purpose, hence it reflects different costs for different purposes. For the purpose of product pricing the costs of all areas of the value chain required to bring a product to a customer (including marketing costs) are included. For the purpose of financial statements only manufacturing costs are assigned to a product. These costs are also referred to as unit costs and are calculated by dividing total manufacturing costs by the number of units manufactured (BHIMANI et al., 2008).

The unit costs of one kg compost were used also to determine the marketing costs. Since it is planed to advertise the collection and treatment service by providing the customers with 10 kg of compost per UDDT per year.

4.5.5 Scenarios

“The scenarios are projections of a potential future. They are combination of estimations of what might happen and assumptions about what could happen, but they are not forecasts of what will happen” (FAHEY and RANDALL, 1998, p.7). The key elements of scenarios are driving forces, logics, plots and end states. Whereby the driving forces are forces that shape and propel the particular plot. They can be segmented in environmental forces and actions of institutions (e.g. economic, social, cultural ecological, technical events, trends and developments). And “scenario logics constitute the rationales that underlie a scenario plot” (FAHEY and RANDALL, 1998, p.10). Finally the end states are speculative projections based on a specific set of assumptions, which reflect the dynamic of the future. Thus “scenarios help managers see what possible future

might look like (end states); how these future might come about (plot) and why they might occur (logics)" (FAHEY and RANDALL, 1998, p.12).

The method used to develop scenarios is the future backward approach (compare chapter 5.2.1.3). In this process a number of end states are first identified and then the plots are developed, respectively the essential driving forces are determined, to show what would have to happen for the end states to emerge from the present. The advantage of this approach is that even with a small amount of data interesting and provocative scenarios can be suggested (FAHEY and RANDALL, 1998). These "what if" alternatives and their affect on the operating profit are graphed by means of breakeven points (compare chapter 5.2.2 Business Plan, section IX. Financial Plan, schedule 4).

5. Results

The presentation of results is divided into three sections:

1. The operational concept of the human waste management service.
2. The analysis of the potential profitability of the human waste management system.
3. The verification of the hypothesis hence the answer to the question if MEWAREMA can operate profitable and be considered as a social business.

In order to elaborate the operational concept the basic conditions were combined with realistic assumptions. The potential profitability is analysed by means of a business plan consisting amongst others of a marketing plan, operational plan, projected income statement and a breakeven analysis. In addition the calculated costs are compared to the anticipated benefits, which finally allows the verification of the first main hypothesis. Moreover MEWAREMA's properties are investigated according to the principles of a social business in the third section.

5.1 Operational concept

The operational concept developed can be described as: **Community-based, resources-oriented management of separated human waste**. The CBO MEWARMA is working as a small business engaged in the collection, transportation and treatment of separated human waste (faecal matter and urine from UDDTs). The transportation is carried out by means of a donkey cart and the treatment is accomplished by co-composting at a community-based facility. The underlying assumptions of the concept (Figure 23) are:

The Community-based organisation:

- Is licensed by the municipality to offer solid waste management in two estates;
- Operates without financial government intervention;
- Operates in two estates where the ownership structure of the built-up plots is legally recognized.
- Receives a fee for the service of collection of faecal matter from UDDT users.

The UDDT-owner (landlord/ladies):

- Receives a loan from the Family Bank to cover the capital investment cost of one or more UDDTs (equipped with three faecal matter collection container).
- Will be charged with an emptying fee of 100 KES per 50 litre container of faecal matter or urine.
- Receives 10 kg of compost per UDDT per year as an incentive to use the collection service (and the UDDT appropriately).

Collection, transportation and treatment

- Faecal matter containers from UDDTs are emptied manually by two trained collection and transport operators after a minimum storage time of three month.
- Faecal matter will be transported with a purpose made donkey cart to the treatment plant.
- A faecal matter secondary-treatment plant for co-composting. i.e. a drying shed and required equipment, is available to allow a hygienically safe production of compost. Responsible for this work are as well the two trained labourers.
- The moisture content of the compost will be adjusted using urine, which saves water and enriches the compost with nutrients.

- The co-composting process will take about three month.
- 100 kg faecal matter can be converted into about 210 kg compost; the mixing ration of faecal matter and organic waste is 1:2; volume reduction of 30 % occurs during co-composting.
- NAWACOM, the only organic fertilizer manufacturer in Nakuru, will buy the compost at 5 KES/kg. The market price for organic fertilizer is 1,000 KES per 50 kg bag (NAWACOM, 2009).

A simplified operational procedure is illustrated in the following scheme (Figure 22). Whereby the brackets indicate facts that do not apply yet.

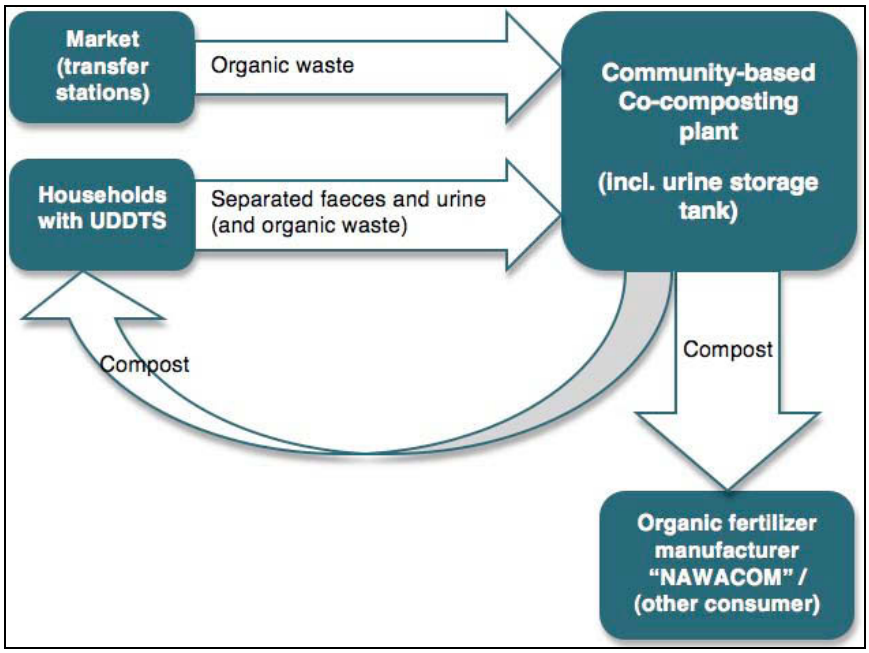

Figure 22 Operating procedure

All stakeholders involved and the related concurrent flows of value and supply are illustrated in Figure 23. The enabling environment is represented by the municipality and the present microcredit program. The dependencies between MEWAREMA and the municipality/ community consist of duties and responsibilities (e.g. regulation and control) and the benefits gained to the municipality/ community by supporting MEWAREMA. Moreover, the values exchanged and the service delivered between the UDDT owners (who act as service customer as well as supplier to MEWAREMA) and MEWAREMA are illustrated corresponding to the assumptions mentioned above. Furthermore, the business relations between MEWAREMA and the end-consumer are presented. Whereby the end-consumer can be split in NAWACOM and potential other customer (e.g. farmer) who purchase the compost directly from MEWAREMA or purchase organic fertiliser from NAWACOM. The interactions between these customers (compost or organic fertilizer user) and the Municipality/ community are as well displayed (e.g. compost demand creation).

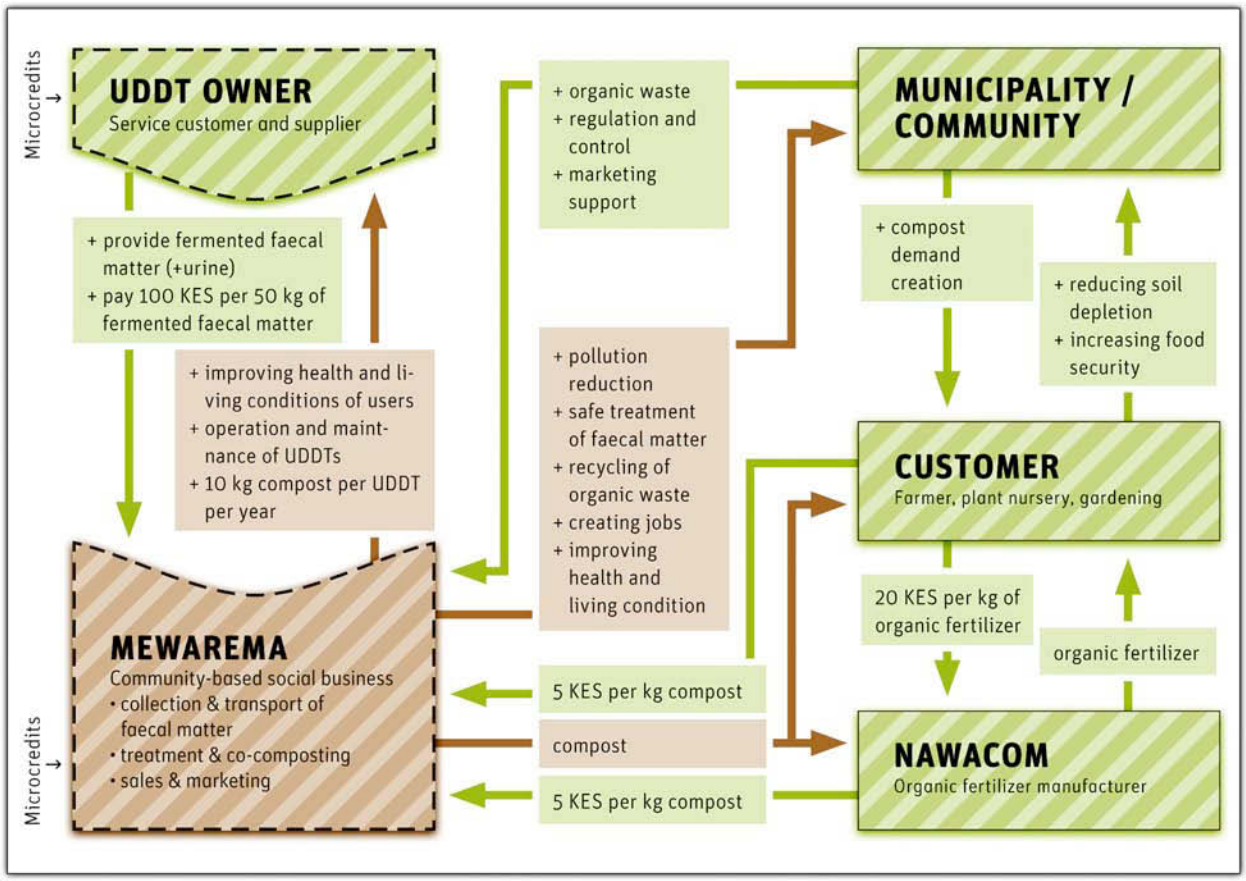

Figure 23 Operational concept of the human waste management service

5.2 Analysis of the potential profitability

This chapter consist of three sections: 1. Input data and assumptions, 2. Business plan and 3. Cost and benefit analysis. Whereby in chapter 5.2.1 Input data and assumptions the main conditions and results of the calculation included in the business plan are summarised. Furthermore the end states and potential driving forces of the applied scenarios are explained. Followed by a detailed business plan in chapter 5.2.2 and a cost and benefit analysis in chapter 5.2.3 where calculated costs are compared to anticipated benefits.

5.2.1 Input data and assumptions

5.2.1.1 Projected income statement

The income statement consists of the costs (Table 7) and revenues of the **service** (collection and transportation) and the **manufacturing** (co-composting/treatment) branch.

The income statement of the service branch comprises the revenues from the collection and transport service (100 KES per 50 litre container) and the costs, which are divided into:

- Wages (300 KES per day per labourer) and
- Other costs (Donkey food (20 KES per month), water (10 KES per working day), maintenance cost of donkey cart (7 % of investment cost per month)).

The revenues of the Manufacturing Branch result from the amount of compost sold (5KES per kg). The costs in the manufacturing branch are composed of cost of goods sold and operating costs. Cost of goods sold comprises:

- The direct manufacturing labour (300 KES per day per labourer).
- Indirect manufacturing costs (water,10 KES per working day, and maintenance cost of the co-composting plant,5 % of investment cost).
- The direct material used costs are considered to be zero since faecal matter is purchased within the service branch and organic waste is collected from the dumpsite.

The operating costs are compost of administration (salary for the supervisor, 2,400 KES/ year) and marketing costs (advertising, 50 KES per UDDT).

Table 7 Collected cost data used in income statement

	Costs (KES)	Reference
Wages (per day per labourer)	300	Mr. Kilonzo (MEWAREMA)
Salary of supervisor (per year)	2400	Mr. Kilonzo (MEWAREMA)
Other costs:		
▪ Donkey food (KES per month)	20	Mr. Kilonzo (MEWAREMA)
▪ Maintenance of donkey cart (7 % of investment cost) (per month)	300	Mr. Muchiri (ROSA NAKURU)
▪ Maintenance of drying shed (5 % of investment cost) (per year)	320	Mr. Muchiri (ROSA NAKURU)
▪ Water (20 litre per working day)	10	Mr. Kilonzo (MEWAREMA)
Marketing cost (per UDDT per year)	50	costs of 10 kg produced compost inclusive transport (calculated)
Selling price per kg compost	5	Ms. Millie (NAWACOM)
[Market price organic fertilizer 50 kg bag	1000	Ms. Millie (NAWACOM)]

The depreciation (equipment, donkey cart) could not be determined and is therefore not included in the calculation. However, it can be assumed that earnings from MEWAREMA's solid waste collection activity can cover those costs. Tax expenses are as well not part of the projection. For further assumptions (number of customers, etc.) and the listed income statement please refer to section IX of the business plan.

The projected income statement reveals that under the assumptions made the CBO MEWAREMA could operate profitable by year four, due to the revenues of the manufacturing branch (compost sold) even though the operation of the collection and transportation is not cost-effective.

5.2.1.2 Breakeven point

The breakeven point depends on the size of operation therefore the calculation results in different breakeven points per year, as presented in Table 8. Further explanations can be found in section IX of the business plan in chapter 5.2.2 (see also appendix 8).

Table 8 Breakeven points

		Year 1	Year 2	Year 3	Year 4	Year 5
Selling price per unit	KES	5.00	5.00	5.00	5.00	5.00
Fixed costs	KES	67,642	67,642	67,642	67,642	67,642
Unit variable cost	KES	1.31	0.81	0.85	0.77	0.76
Unit contribution margin	KES	3.69	4.19	4.15	4.23	4.24
Break even output	kg	**18,324**	**16,144**	**16,288**	**16,007**	**15,940**
Break even sales	KES	91,618	80,722	81,442	80,035	79,699

The analysis allows concluding that under the give conditions and the assumptions made the sale of ca. 16,300 kg per year would be necessary to breakeven. As described in the next chapter further breakeven points have been calculated to analyse the affect of different scenarios. All breakeven points are presented in charts in the business plan.

5.2.1.3 Scenarios

In the course of the business plan different scenario end states have been developed. The entire scenario plot cannot be described due to a lack of sufficient information.

The end states of optimistic scenarios can be described as:

Scenario 1: Increase in service customer i.e. UDDT owners that are willing to pay for the collection service.

Scenario 2: An increased price for the produced compost is paid by NAWACOM.

Scenario 3: The municipality subsidises the collection and transport service with 300 KES per UDDT.

Scenario 4: Urine can be sold to the fertilizer industry.

The end states of pessimistic scenario would be that:

Scenario 5: Current customers terminate using the collection service.

Scenario 6: The demand for organic fertilizer respectively for compost decreases.

Table 9 summarises the potential driving forces leading to the different scenario end states described above.

Table 9 Driving forces of scenarios

Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Social pressure Prestige Environmental awareness Economical growth Hygiene education Demand promotion activities	Organic fertilizer demand increase Less subsidy on chemical fertilizer Chemical fertilizer price increase (oil price)	Capacity building for resources-oriented sanitation in the municipality Cost and benefit analysis of reduced environmental contamination and reduced cost in the health care system Fair distribution of public funds	Positive research result for the recovery of urea in urine	Negative economic growth Lack of environmental awareness Lack of hygiene education	Increase of subsidy for chemical fertilizer Insufficient marketing for organic fertilizer

The financial impact of scenario 1, 2 and 3 are presented by means of breakeven points in section IX of the business plan. It was waived to illustrate the impacts of scenario 4 since the necessary assumptions would be highly speculative. Besides scenario 5 and 6 are not illustrated due to the fact that profitability would not be achievable within five or more years.

5.2.1.4 Employment opportunity

It is assumed that two labourer work for approximately 4 days a month in the service branch (collection and transport) and in addition two labourer work for 8 days a month in the manufacturing branch (co-composting). They will earn 300 KES per day thus if both task are carried out by the same two labourer they end up earning each 3.600 KES per month, working for ca. 12 days a month. Moreover the number of required working days increases successively with an increase in customers.

The minimum wage in Kenya differs depending on location, age and skill level. In Nakuru the minimum wage per month is 3.999 KES to 4.572 KES and the basic minimum wage per day 192 KES to 221 KES (KENYA GAZETTE, 2004 in OTIENO 2005).

5.2.2 Business Plan

This chapter presents the business plan developed for the community-based organisation MEWAREMA comprising the following sections:

Table of contents

I. Executive Summary

The business plan has been developed to present MEWAREMA to prospective investors and to assist in raising 10,000 KES of equity capital needed to offer a reliable service and to begin the sale of its product. All financial data are given in Kenyan Shillings (KES).

The Company

Menengai Waste Recyclers Management (MEWAREMA) is a community-based organisation (CBO) that is anxious to diversify its operation. During the past eight years MEWAREMA has become the largest compost manufacturer and a licensed operator of solid waste collection in two estates in Nakuru, London and Hilton, where sanitary infrastructure is very poor. At present it develops a collection, transport and treatment service for excreta from Urine Diverting Dry Toilets (UDDTs).

The ROSA project in Nakuru has identified UDDTs as an appropriate option for excreta management within certain areas of Nakuru Municipality (Moseti, 2010). UDDTs are toilets that can be used within the holistic approach, which views human excreta as a resource and aims at closing the nutrient cycle. UDDTs collect faeces and urine separately and have furthermore the following advantages (Morgan, 2004):

- Low capital and operation costs
- Construction with locally available materials
- Permanence of structure (container collecting excreta can be exchanged)
- Prevention of diseases and reduction of health risk
- Protection of the environment
- No use of water to flush away excreta
- No odours and flies if used and maintained correctly
- Nutrient recovery is possible (crops grown with fertilizers from human excreta grow faster and bigger than the ones without them)

Experience has shown that many projects aiming to improve sanitation services in developing countries, although providing adequate infrastructure facilities, fail due to difficulties in operation and maintenance. To counter this development and secure a sustainable solution MEWAREMA offers a collection and transport service for excreta from UDDTs and operates a co-composting plant to manufacture hygienically safe, high quality compost. MEWAREMA's current work of composting and solid waste collection is highly appreciated in the community. MEWAREMA possess a donkey cart for transport service and a drying shed for co-composting. Based on the detailed financial projections, it is estimated that 10,000 KES are required to start these two operations successfully. The funds received will be used to build an urine storage tank and to finance the operating loss during the first two years of operation.

Market Potential

Market research conducted during the course of the ROSA project shows that there is a demand of resources-oriented sanitation technologies like UDDTs in Nakuru. Especially in low-income areas characterized by inadequate water supply and unfavourable soil structure for pit latrines, UDDTs represent an appropriate alternative (Moseti, 2010). Thus, a remarkable up-scaling of UDDTs can be observed since the first implementation of UDDTs by the ROSA project in 2008. During the year 2009 a total of 20 UDDTs have been build in the target area privately financed by landlords/landladies. This development will increase the demand for MEWAREMA's collection and transport service of faecal matter since over 70 percent of landlords/landladies owning an UDDT require and are willing to pay for the faecal matter collection service. The second target market are compost buyers. Since there is a demand of organic fertilizer in the region NAWACOM (the leading organic fertilizer seller in the region) is

disposed to pay 5 KES for 1 kg compost from faecal matter. The compost will be further processed by NAWACOM and sold as organic fertilizer. Researches indicate that virtually all farmers in the region use fertilizer and the globally rising price of chemical fertilizer leads to an increased demand for less expensive organic fertilizer. Furthermore it could be observed that small-scale farmers tend to prefer organic fertilizer due to its slower release of nutrient, which is advantageous in the rainy season (Bräustetter, 2007). Additionally, the ongoing research by Jomo Kenyatta University on production of eco fertilizer from urine, could lead to a profitable market for urine as well.

Major Milestones

The two most important equipments, the purpose made donkey cart and the drying shed, are ready for use in June 2010. Contracts with UDDT owner represent the next milestone which lead to the first customers served. The urine storage tank still needs to be built. NAWACOM the bulk buyer of the produced compost guarantied to purchase the produced compost. A contact between NAWACOM and MEWAREMA still needs to be concluded.

Distinctive Competence

MEWAREMA is uniquely positioned to take advantage of this market opportunity due to the managerial and field expertise of its founders, and its product and service distinct benefits. Given that MEWAREMA has been operating as CBO since 2002 it inheres in customer orientation and long time experiences in composting.

Financial Summary

Based on the detailed financial projections and MEWAREMA receives the required 10,000 KES in funding, it will operate profitably by year four. Table 10 summarizes projected financial information. Based on the main assumptions that the number of UDDTs served rises from 24 UDDTs in the first year to 30 UDDTs in the fourth year and that the manufactured compost will be sold at 5 KES per kg.

Table 10 Summary of financial information (in KES)

	year 1	year 2	year 3	year 4	year 5
Service-branch					
Revenues	18,800	19,200	21,600	22,800	22,800
Operating Profit	-14,290	-14,500	-15,150	-15,170	-15,170
Manufacturing-branch					
Revenues	48,300	72,450	80,850	89,250	91,350
Gross margin	-14,100	10,050	18,450	26,850	28,950
Operating profit	-17,700	6,450	14,650	22,950	25,050
Overall profit (loss)	**-31,990**	**-8,050**	**-500**	**7,780**	**13,780**

II. General Company Description

MEWAREMA is a CBO based in Nakuru, Kenya. The CBO was established in 2002 and has currently 24 members. Initially it was founded to produce and sell compost made of organic waste from the markets, however, MEWAREMA is meanwhile licensed to collect solid waste from an estate adjoining the dumpsite. At present MEWAREMA wants to diversify its operation by offering a faecal matter collection and transport service to landlords/landladies owning one or more UDDTs. Furthermore MEWAREMA operates a treatment plant to co-compost organic waste with the faecal matter collected into a hygienically safe, high quality compost. MEWAREMA is therefore functioning as service and manufacturing business. The organisation aims to improve the quality of life for disadvantaged inhabitants and to contribute to resource recovery through efficient organic and human waste management.

III. Product and Service

The product MEWAREMA offers is high quality compost made out of faecal matter and organic waste. Co-composed excreta are rich in nutrients (nitrogen, phosphorous, and potassium) and organic material, thus enhance sustainably the fertility of topsoil. The organic material in compost acts as soil conditioner and improves the structure and water holding capacity of the soil. Compost reduces the need of artificial fertilizer, and therefore saves important natural resources (phosphor) and contributes to a sustainable soil management. This compost will be further processed by an organic fertiliser manufacturer and than offered at half the price of artificial fertilizer. Treatment facilities are already available and the operators are being trained to guarantee the required high level of management.

The service of collecting and transporting faecal matter from households to the treatment plant will be done professional, reliable and customer oriented. Depending on the number of households of each compound (using one or more UDDTs) the collection and transportation service will be carried out in regular intervals. The transportation will be done with a purpose-made donkey cart and two trained workers. The purpose-made cart is under construction and the operators are being trained in the safe handling of faecal matter. If required the operators perform repair work (blocked pipes, etc.) thus ensuring the durability of UDDTs.

IV. Marketing Plan

IV.1. Market definition and Opportunity

MEWAREMA will offer a collection and transport service of faecal matter in 2 estates (London and Hilton) in Nakuru. Additionally it will direct its effort to operate a co-composting plant where hygienically safe and high quality compost will be produced. These two branches complement a resources-oriented sanitation systems started by the ROSA project in 2007. Since then sanitation issues are increasingly gaining priority and UDDTs have been proven to represent an advantageous and sustainable alternative to pit latrines in the area. The success of the supporting micro-credit program (offered by Family Bank under the ISSUE-2 program, to defray capital investment costs for sanitation facilities, like UDDTs) highlights a broadening demand for sustainable sanitation and especially UDDTs in the region. UDDT owners in the area rely on a collection and transport system therefore the demand for this service will increase. The two estates where UDDTs are in use or currently under construction and faecal matter will be collected are in proximity to the co-composting plant. The high-quality compost produced at the co-composting plant will be sold to the bulk buyer Nakuru Waste Collectors and Recyclers Management (NAWACOM) investment society, which is the main supplier of organic fertilizer in Nakuru. Therefore the market addressed has to be divided in to two separate industries:

1. Resources-oriented sanitation industry
2. Organic fertilizer and compost industry

IV.1.1. Resources-oriented sanitation industry

Since it is a new market, industry data regarding the service of UDDT specific collection and transport of faecal matter in peri-urban areas are worldwide very limited. In some cases the reuse of excreta from UDDTs as organic fertiliser is not promoted even though it is an essential aspects of resources oriented sanitation. In other cases a comparable transportation service is currently under development and results have not yet been published. In one case however in Arba Minch, Ethiopia, a transport service for urine and faecal matter could successfully be installed during the ROSA project. This is due to the fact that UDDT owners are willing to pay for the service, farmers use urine as organic fertilizer and co-compost producers register an increase in sales (Kassa, 2010). A specialised collection and transport service for faecal matter of UDDTs does neither exist in the urban and peri-urban area of Nakuru nor in the rest of Kenya.

In the service area of MEWAREMA a sewerage system is not provided by the municipality council of Nakuru (MCN) and pit latrines are the norm. The existing sanitation industry sector has therefore been limited to pit latrine construction and emptying. Since the ROSA project introduced UDDTs in the area (3 UDDTs in a residential plot, 9 in a school and 3 in a nursery) an up-scaling of UDDTs by landlords/landladies can be observed. In the years 2009 and 2010 around ten landlords invested in about 20 UDDTs in the target area of MEWAREMA.

The construction of UDDTs is done by local masons who have been specially trained in the course of the ROSA project. To be able to pay the construction cost an adequate micro-credit program is at landlords/landladies disposal. Regarding the operation (transport and treatment of faecal matter) of resources-oriented sanitation systems one has to make comparisons with solid waste management. Private service providers (including CBOs) manage 30 % of solid waste collection in Nakuru (ROSA NAKURU TEAM, 2007). The MCN licenses these garbage collection companies and households have to subscribe individually contracts with private solid waste collectors (according to a by-law, released in April 2007) (Bräustetter, 2007). Waste fees range from 50 KES to 200 KES per month depending on the size and income of the household (ROSA NAKURU TEAM, 2007). Identically MEWAREMA will be licensed to collect faecal matter and urine, and make contracts with the UDDT owners.

IV.1.2. Organic fertilizer and compost industry

Nationwide the fertilizer use (chemical and organic) has increased from about 200,000 tons in early 1990s to over 450,000 in 2007. However, the fertilizer consumption level of 9 kg/ha is still very low in Kenya in comparison to > 70 kg/ha in Latin America and Asia. The Tegemeo Institute of Agricultural Policy and Development analyses trends in the Kenyan agricultural productivity over the last 14 years and revealed the following data concerning small-scale farming. The use of organic fertilizer is rising in importance, and reflects farmers' attempts to raise soil fertility. Thus the proportion of small-scale farmers using organic fertilizer increased from 44 % in 2,000 to 50 % in 2007. Nakuru belongs to the agro ecological zone named High-Potential Maize Zone where 93.6 % of small-scale farmers used fertilizer in 2007 and the proportion of small-scale farmers using organic fertilizer increased from 22 percent in 2,000 to 24 percent in 2007. Households in the high-potential maize zone own an average of 10 acre (i.e. 0.4 ha) and crop sales are an important contributor (38.3 % in 2007) to household's income in the region. 69,4 percent of the cropped area was allocated to fields with maize and the fertilizer use rate on maize in the main season was 75 kg/acre (Mathenge, 2010).

Nakuru possesses one organic fertilizer manufacture owned by Nakuru Waste Collectors and Recyclers Management (NAWACOM) investment cooperative society. NAWACOM purchases compost from one compost plant at the dumpsite (run by MEWAREMA) and from about 14 smaller composting sites in the peri-urban areas. Before the compost is bought (1 kg for 5 KES), it is sampled for quality. Then it is further processed and upgraded, i.e. the nutrient content is increased, to obtain a high quality organic fertiliser, sold as 'Mazingira Organic

Fertiliser'. The organic fertiliser is sold at 1,000 KES per 50 kg bag, whereas a 50 kg bag of chemical fertiliser cost 1750 KES (Bräustetter 2007). In 2009 the sales Volume of NAWACOM was estimated to be around 6 tonnes per month.

It can be summarised that both industries related to the work of MEWAREMA are growing.

V.1.3. Target Markets

As previously mentioned, MEWAREMA plans to approach the market place through offering a transport service for faecal matter from UDDTs and selling a high quality compost mainly to NAWACOM. Thus target markets can be segmented into two parts: UDDT owners and compost buyer.

UDDT owners

UDDT owners are landlords providing one ore more UDDTs to tenants on his/her plot. landlords/landladies possess a regular income and are capable to pay for a transport service on a regular basis. A survey revealed that 4 out of 6 landlords/landladies (already owning an UDDT) would highly appreciate and are willing to pay for a collection service. Since most of the landlords/landladies can't reuse the faecal matter on the plot (due to limitation of space in the estate) they rely on a collection and transport service, which has to be affordable and especially reliable.

The target group lives in the estates Hilton and London with approximately 2000 inhabitants, in close distance to the treatment plant. In these two estates ca 85 % of the inhabitants use pit latrines and like stated above a process of rethinking toward sustainable ecological sanitation started. A study on the willingness of landlords/landladies to adapt UDDTs in their plots established that:

- Out of 10 landlords interviewed in Hilton 80 % indicated they preferred UDDT. 10 % chose pit latrines, while the other 10 % preferred pour flush toilets with a septic tank (Muchiri, 2009).

At present several landlords/landladies still fear to be left with accumulated faeces and urine uncollected if they choose the UDDT option. By providing a reliable collection and transport service, landlords still having reservations will be convinced and consequently opt for UDDTs and become customers of MEWAREMA.

The owner and users might be sensitive to sanitation and health issues and a supporter of ecological sanitation.

Compost buyer

The main and so far only compost buyer in the region is NAWACOM. It was initially founded as a CBO by people who earn their living by retrieving reusable materials from solid waste. NAWACOM is registered as an investment cooperative society since 2006. Affiliated CBOs can become a member in the cooperative through buying 100 shares at 5 KES each. However only parts of NAWACOM's members are shareholders hence the cooperative has 96 members while the CBO has 336 members (Bräustetter 2007). Rewards from waste recycling activities are subdivided to the cooperation's members according to their shareholding.

Farmers in the Nakuru area seem to prefer organic fertiliser to chemical fertiliser – even if the total Nitrogen, Phosphorous, and Potassium level is lower. This is due to the fact that the chemical fertilisers are leached quickly during the wet growing seasons, when fertiliser is usually applied and also needed most by the plants. The organic fertiliser releases the nutrients slower and has thus a prolonged fertilising effect (Bräustetter 2007).

IV.2. Competition and other influences

The viability of resource recovery systems depends upon a number of important technical, socio-economic and political relationships. Macro-economic influences such as international price and trading policies, government policies such as import regulations, and municipal policies also affect the level of resource recovery that will be feasible (Lardinois, 1993). The Worldwide Corruption Perceptions ranking of countries published by Transparency International in 2009 indicates the high level of corruption in Kenya (Rank 146 out of 180 - a lower rank means more perceived corruption) (Transparency International, 2009). This however should not have unpredictable impacts on the economic performance since MEWAREMA worked before as solid waste collector. The risk of political instability in Kenya needs to be considered. The post election violence in 2007/2008 for example affected communities in Nakuru. People were displaced, community groups disrupted and many businesses were destroyed (SPRUNG and STEVENS, 2009). Changes in government regulations concerning sanitation and agriculture, especially the ban on reuse of excreta as fertilizer, would be favourable although they are not yet foreseen.

IV.2.1. Collection and transport service

MEWAREMA has a monopoly position since no one else is offering this kind of collection and transport service. The risk of imitators in future is neglectable as the license obtained by the MCN guaranties the monopole in the two estates. It is assumed that the Municipality will never provide a sewerage system and that the integration of MEWAREMA as a CBO in the two estates will lead to wide acceptance, use and appreciation of the service. Risks that could affect the performance of the service are the following:

- landlords emptying the faecal matter container by themselves into abandoned pit latrines and thus saving on the collection fee.
- Different toilet solutions compete against the UDDT, however, particularly for soil structure reasons (volcanic rock) UDDTs rank among the most favourites in the area.
- Failure by households to honour the contract. However, for the catchment area of MEWAREMA it is reported that most households pay their fees regularly

IV.2.2. Composting

Since NAWACOM is the only fertilizer manufacture in the region MEWAREMA highly depends on the sales of NAWACOM and the overall demand for organic fertilizer in the region. Chemical fertilizer are subsidised by the government and therefore distorts the competition. However the rising price of chemical fertilizer driven by the increase in oil prices is presumably contributing to a rethinking towards sustainable farming. This could already be observed at the end of 2007 when rising global fertilizer prices gave NAWACOM's sales a significant boost, since farmers in the region opted for their cheaper organic fertilizer (SPRUNG and STEVENS, 2009)

Fertilizer prices, closely linked to energy prices, increased five-fold between 2002 and 2008. Even though they declined considerably during 2009, their long-term real average is expected to be 80 percent higher than their early 2000s levels (Figure 24), raising the cost of producing most agricultural commodities (World Bank, 2010). The Constant 2000 Dollars is a reference value taking inflation, etc. into account.

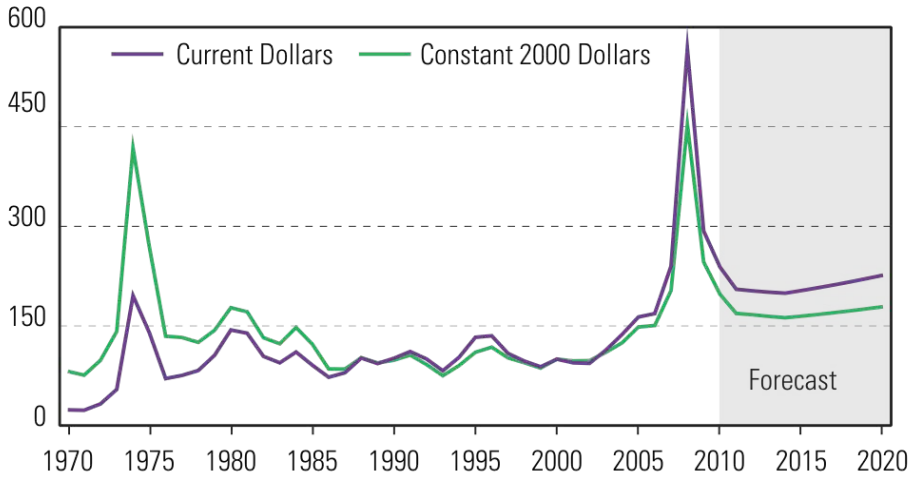

Figure 24 Development of the Fertilizer Price Indices (World Bank, 2010)

IV.3. Marketing strategy

MEWAREMA plans to limit it service to the area of two estates which are not supplied by a sewerage system, have favourable features for UDDT implementations and are in short distance to the co-composting plant.

The plant workers will sell the produced compost to the bulk buyer NAWACOM or if there is a demand directly to farmers.

IV.3.1. Pricing strategy

The price for the service of collecting and transporting 50 litre of faecal matter is 100 KES. The price was derived from discussions with potential customers and is set as low as possible to convince UDDT owners to use the service. An increase in price for economic reasons is not planned to avoid a loss of costumers. Depending on the number of household and UDDTs per plot an average payment of 50 KES per month and UDDT is assumed. Compared to the price paid for water in the area: 10 KES per 20l respectively 400 KES to 3,000 KES per month per household the costs for the faecal matter collection service can be considered as affordable.

The selling price of the compost sold to NAWACOM is sill under negotiation. At present NAWACOM buys 1 kg of compost for 5 KES. The price for compost sold directly to farmers will only cover the manufacturing costs. This is due to the fact that the market for organic fertilizer still needs to be further developed. If farmers are willing to pay (at least the manufacturing cost) for the compost this has to be considered already as a great success. In the following years the price can than be successively increased.

IV.3.2. Advertising, Public Relations and Promotion

Promotion of the collection and transport service followed by free advertising of the compost:

To convince landlords/landladies to use MEWAREMA's collection and transport service they will receive 10 kg of compost per UDDT per year. (Costs: 50 KES per year per UDDT.) This incentive is furthermore a kind of sales promotion since the landlords/landladies test the free compost samples in their own garden or transmit or sell it to relatives or neighbours. The provided amount of compost per UDDT per year can be increased as soon as MEWAREMA generates profit.

Promotion of the organic fertilizer and the compost:

To promote the organic fertiliser, in and around Nakuru several demonstration sites, showing plant growth enhancement, were established by NAWACOM. Promotional prices of 1750 KES for 150 kg organic fertiliser (which the same price of 50 kg chemical fertilizer) try to attract more customers.

To further promote the use of compost to potential customers (horticulture, gardening, landscaping, plant nurseries, farming) an organic demonstration farm, could be as well installed and operated by MEWAREMA. The produced crop could than be used by members of the organisation or sold.

This would lead to:

- Building awareness in the market about compost;
- Telling customers about the benefits of using compost (soil conditioner);
- Informing customers about the quality and characteristics of the compost;
- Training of customers how to use compost;
- Encouraging customers to buy the compost.

Public relation:

To potential customers of the collection and transport-service branch (Landlords/landladies interested in investing in a UDDT) an advisory service is offered by the ROSA and Practical Action office that provides information on how to build and maintain an UDDT. To rise the demand for the high quality compost the awareness rising campaign (started by NAWACOM and the ROSA project) have to be expanded. NAWACOM has links to the Ministry of Agriculture and to farmers associations to improve the marketing (Bräustetter, 2007). In 2007 a documentary featuring NAWACOM's work which was shown on two national TV channels increased their sales (SPRUNG and STEVENS, 2009). In the end of 2009 a national TV channel produced a documentary about the ROSA project and the use of UDDTs in Nakuru. Further publications in newspaper, radio or TV should be realized in future to prove that UDDT owner are still satisfied and UDDTs can be operated and maintained without difficulties. Using the example of Arba Minch, Ethiopia, sanitation clubs could be founded in schools where UDDTs have been installed. This would lead to a further awareness rising in the families of the pupils.

The municipality founded the Environmental Consortium in 2008 to keep the urban environment clean consequently they might be willing to use the compost in the public green space management in Nakuru.

Related budgets:

The promotional costs for the compost offered to the customers of the collection and transportation service will be very low (KES 50 per UDDT) since the compost is manufactured by MEWAREMA itself. Due to the regular frequency MEWAREMA is working in the target area the cost for the compost-delivery are negligible. The cost of awareness creating campaigns can be partly decreased by using educational-material prepared by the ROSA project. More extensive advertising will be contemplated at a later date after financial resources have been secured or financial support is given.

IV.4. Market research

The ROSA project addressed a variety of research topics amongst others the improvement and adaptation of resources-oriented sanitation technologies and the development of community based operation and management strategies. In 2008 ROSA started to implement 9 pilot UDDTs in Nakuru. The area is regarded as representative for peri-urban areas of

- low income (KES 5,000 – KES 10,000 per month),

- middle to high population density (population of 300 to 4000 people/km^2),
- low sanitary infrastructure and
- unfavourable soil conditions for pit latrines.

Different researches conducted in the course of the ROSA project revealed the following aspects of the target market:

Target area

- Especially areas characterized by inadequate water supply and unfavourable soil structure (rocky or loose soil) offer the best location for UDDTs in Nakuru (Moseti, 2010).
- The two estates comprise plots with simple houses owned by landlords/landladies rented out to several tenants.

User

- The market potential for UDDTs was assessed as good in the target area. A survey (215 questionnaires) revealed that 86 % are interested in using an UDDT if they are not responsible for O&M (Muchiri et al., 2010).
- The users have approved the pilot-UDDTs. It was determined that 91 % to 95 % of the users are satisfied since the toilet has no smell compared to pit latrines. (Muchiri, 2009)
- 47 % of households (user in the residential plot) are willing to clean the vaults at a cost (Muchiri, 2009).
- The number of households willing to pay for maintenance work (cleaning the facility and exchanging faecal matter containers) has not yet been identified. It has to be considered that the households with lower income earn an average of KES 166 per day. This is shared between purchasing water (KES 10-15 per 20 litres), food, shelter and clothing. Thus in most cases it is not an option to charge the households for the maintenance work.

Landlords/landladies (UDDT-owners)

- The landlords, responsible for the current sanitation situation on the plots, dispose of financial means to pay a regular service fee. Furthermore they get financial support from the family bank (under ISSUE-2) to raise the capital investment cost for an UDDT unit on their properties.
- Effective awareness creation, results in landlord's willingness to adopt resources-oriented sanitation systems in the mentioned area (Muchiri, 2009).
- 70 % of the landlords/landladies owning an UDDT are willing to pay a collection and transport fee of 50 KES to 100 KES per 50 litre container faecal matter
- 30 % of the landlords willing to pay for the faecal matter collection are as well willing to pay 100 KES per 50 litre container urine collected.
- Out of 11 landlords/landladies (UDDT owners or planning to construct an UDDT) 9 landlords have a garden and one landlord has a farm. All 11 landlords are willing to use compost made of faecal matter.

Organic fertilizer demand

- There is a demand of organic fertilizer in the region therefore NAWACOM (the leading organic fertilizer seller in the region) is disposed to pay 5 KES for 1 kg co-composted faecal matter.
- NAWACOM samples and process the compost to sell a high quality organic fertilizer at 1,000 KES per 50 kg bag or 1750 for 150 kg. (The price of a 50 kg bag of chemical fertiliser is 1750 KES (Bräustetter, 2007)).

Farmer

- A general survey on farming practices in Nakuru conducted by Foeken and Owuor (2000) reveals that farming is very common in Nakuru. Most people cultivate the common food crops, mostly for their own consumption or for commercial purposes. And

almost all crop cultivators used at least one type of fertilizer. Of the 594 households interviewed in Nakuru town, 366 (62 %) could be classified as urban dweller farming in the rural areas.

- Bräustetter (2007) states that farmers in the Nakuru area seem to prefer organic fertiliser to chemical fertiliser since the organic fertiliser releases the nutrients slower.

Up-scaling

- Since UDDTs proved to be a favourable alternative to the common pit latrines in the area, an up-scaling of UDDTs can be observed. In 2009 and 2010 21 additional UDDTs have been implemented on 9 different plots.

In Arba Minch, the Ethiopian ROSA pilot city, an excreta-transportation service for UDDT owner has already been successfully implemented. The customers pay between 0.30 EUR and 1.60 EUR and signed a contract with the transport service. Firstly, it was necessary to develop the market for co-compost but after several awareness rising campaigns and training of farmers the demand is steadily increasing and a first bulk buyer could be attracted (Kassa, 2010).

IV.5. Sales forecast

Figure 25 shows the sales forecast for the first two years based on the assumption that NAWACOM will buy the whole amount of compost manufactured each month. An additional revenue stream will be the collection of faecal matter and urine from UDDTs. The faecal matter and urine collected will be used in the composting process. The compost sale begins three months after the first faecal matter collection due to the time the co-composting process takes. The distribution of UDDT emptying throughout the year is simulated based on actual numbers of customers, the real number of UDDTs per customer and the relating fill up times of UDDT-container, which have been confirmed via telephone-survey (see Appendix 10).

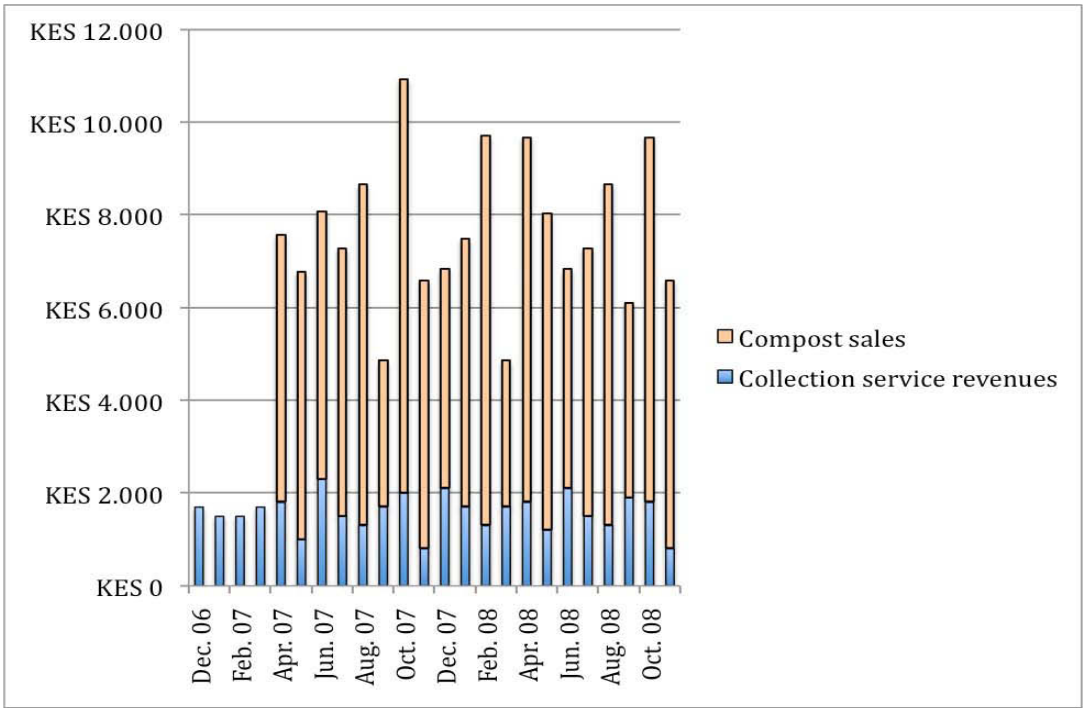

Figure 25 Compost sales and collection service revenues in the first two years of operation

In general the calculation of different distribution scenarios shows that a more equal distribution of UDDT-emptying throughout the year, i.e. around 11 emptyings per month in the first year, saves working days and increases therefore the overall profit.

How many new customers to be expected in the following years could not be further determined however some of the customers in 2011 stated that they are planning to build more UDDTs on their plot in future. Figure 26 shows, for the first year, the number of customers and the anticipated service revenue calculated from the number of UDDTs per customer, the fill up time and the emptying fee of KES 100 per faecal matter or urine container. Only 3 of the first 9 customers are willing to pay for the urine collection this is however enough to cover the amount of urine needed in the composting process.

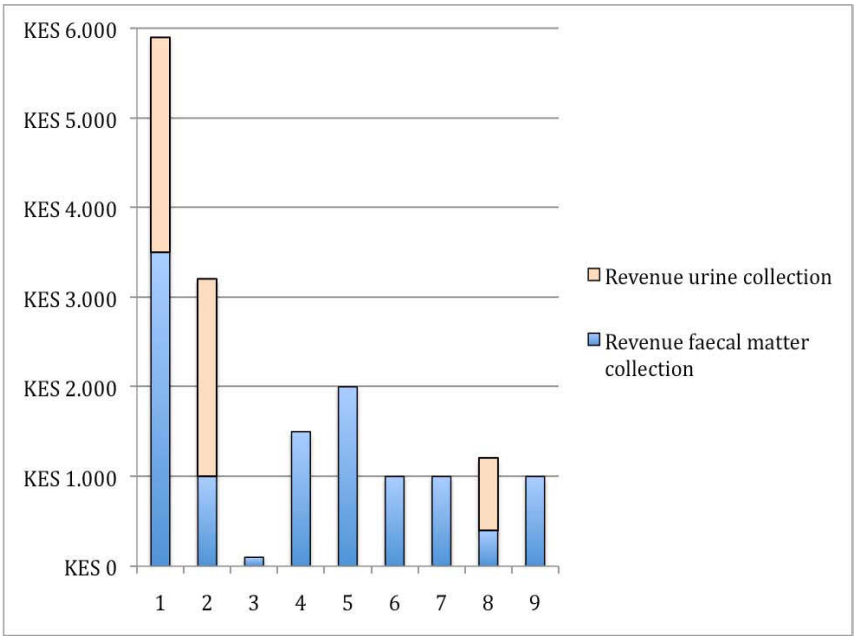

Figure 26 Service revenues per customer, first year of operation

A pessimistic scenario would be if NAWACOM fails to take the compost and service customers fail to pay for the collection service despite the contracts concluded.

A optimistic scenario would be a growth rate of 11 percent in the service branch (which is an equivalent of one new customers per year with at least two UDDT each and a fill up time of the faecal matter container of two month) and a rise in the compost selling price of 40 percent (from KES 5 per kg compost to KES 7 per kg compost). Section IX of the business plan presents these different scenarios.

IV.6. Supporting Material

Regrettably letters of intent, letters of support (NAWACOM) or contracts cannot be presented for this thesis.

V. Operational Plan

Operating procedure resulting from UDDT application is in this case a system consisting of excreta separation, containment, collection, transportation, treatment and re-use of urine and faeces (Figure 27). Whereby MEWAREMA is involved in the collection, transportation and treatment of faecal matter via co-composting additionally it sells the compost to re-user.

Figure 27 Simplified scheme of operating processes resulting from UDDT application

In the following this processes are explained in detail.

V.1. Collection and Transport

MEWAREMA has the following resources available for the faecal matter collection and transport service:

- A donkey cart and two donkeys (financed by a loan from the Family Bank under the ISSUE 2 program). The donkey cart has a capacity of 300 kg, sufficient to cover future demand. The co-composting site where the faecal matter is transported to is situated in close proximity to the customers.
- Two employees will be responsible for the safe and reliable collection and transport. Furthermore they are trained to maintain the UDDTs (i.e. fixing blocked pipes) and are equipped with protection gear.
- A supervisor will oversee the management of the service.

V.2. Treatment and re-use (Manufacturing of compost – secondary treatment of faecal matter)

The purpose of co-composting is to sanitise the faecal matter and then to allow reuse of the nutrients. In comparison to chemical fertilizers compost increases not only the yield, but also the biodiversity, of the water holding capacity and long-term productivity of soil (Birkhofer et al., 2008). Especially with a poor soil deficient in nitrogen, a farmer can expect very good results and increase the yield of his farm.

In order to produce compost the following resources are utilized.

- The manufacturing facility consisting of a drying shed (financed by Practical Action and now belonging to MEWAREMA) where the collected faecal matter from UDDTs is dried, mixed and co-composted. The 40-square-meter drying shed is located at a dumpsite, which borders on the catchment area of the faecal matter transport service offered by MEWAREMA. If in long term the facility size has to be increased due to operational growth an additionally area is available.
- The working equipment consists of basic tools (spade, fork, etc.) and protection gear (gum boots, gloves, etc.) for the employees.
- The raw materials (faecal matter and organic waste) will be acquired free of charge by the transportation-service branch of MEWARMA.
- Two employees are responsible for manufacturing the compost (nevertheless four employees are trained in total in case of personnel loss). This number will increase with the growth in sale.
- The regular sampling of the compost quality will be subcontracted.

An urine storage tank still needs to be constructed next to the drying shed. According to the WHO guidelines (WHO, 2006) urine should be stored for a minimum of one month to be hygienically safe for reuse.

The open composting process, illustrated in Figure 28 can be described as follows:

Sources:

- MEWAREMA members collect organic waste from the dumpsite (market wastes) and sort them to remove impurities.
- Faecal matter (storage time in the container 3 months) is purchased from UDDTs.

Step one:

- Faecal matter is sieved before decomposition to remove non-organic materials.
- Organic waste and faecal matter are mixed at a ratio of 2:1.
- The materials are arranged in windrows.

Step two:

- The windrows are regularly turned (every 3 days) to ensure adequate levels of oxygen.
- Heat treatment at 55°C for an extended period (18 - 21 days) is necessary. High temperatures are effective in pathogen die-off contained in the faecal matter.
- 50 litres of urine per 1m³ of compost should be added each month.
- To reach optimal moisture content (between 50 %-60 %) water may have to be added.

Step three:

- Compost is left to mature, after 3 months the compost looks like soil.
- Compost is than sieved and ready for sale.

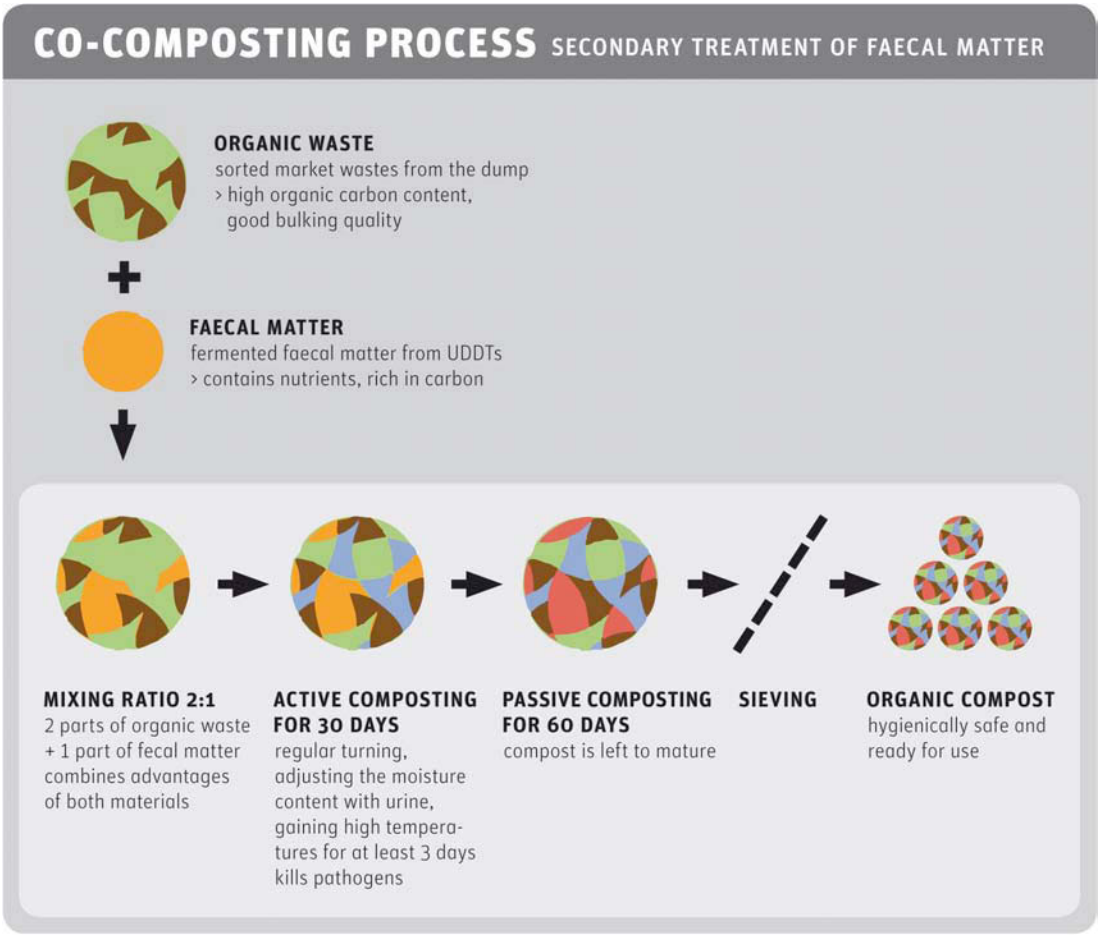

Figure 28 Co-composting process

For the purpose of resources-oriented sanitation the output is an hygienically safe compost which can be used as natural organic fertilizer and soil conditioner or further processed and sold by NAWACOM as 'Mazingira Organic Fertiliser' with a guaranteed nitrogen (N), phosphorus (P), and potassium (K) value of 2.0, 1.5 and 1.8 % of dry matter, respectively.

The compost contributes not only to the income of MEWAREMA and an increase in yields on farms. Co-composting reduces likewise the total amount of waste on the dumpsite and protects the environment from inappropriate disposal of faecal matter.

V.3. Product development

MEWAREMA's employees are trained to produce high quality compost. It is planned to develop the product further through the use of urine as nutrient provider. The nutrient value of the compost can thus be increased without the use of expensive additives and might lead to a higher selling price. In addition the scientific research by the Jomo Kenyatta University investigates the use of urea in urine to produce a high quality and affordable eco fertilizer with specific agronomic variability (ecotact, 2010).

V.4. Other influences

Co-composting

The co-composting relies on two raw materials, faecal matter and organic waste. Faecal matter and urine will always be available from UDDTs. If an UDDT breaks down it can be locally repaired thus guaranteeing the durability of the facility. Some of the used organic waste has been collected on the neighbouring dumpsite. The municipality now plans a replacement of the dumpsite outside of town. Nevertheless the risk of shortfall of organic waste can be neglected since most of the used organic material is not collected on the dumpsite but from market waste which is transferred directly to MEWAREMA. The produced compost is exclusively sold to NAWACOM. In case NAWACOM fails to take the compost a loss in revenues has to be considered.

Transport service

The transport service depends on the availability of the donkey cart. If necessary the cart can be repaired by local garages thus avoiding a longer shutdown. The customers (UDDT owners) ability to pay for the service is related to the overall economic situation of the country. This situation can be negatively influenced by political unrest, which can occur in Kenya.

Protections

The municipality licensed MEWAREMA to conduct the solid waste collection in the Hilton and London estates. This license guaranties MEWAREMA's monopole in the specific area.

VI. Management and organisation

Detailed information on management and organisation of MEWAREMA could not be gathered in the course of the thesis.

VII. Major Milestones

The first milestone has been the construction of the drying shed followed by the approval of the loan for the donkey cart in the beginning of 2010. Being one of the most important equipment, the cart can thus be constructed and is expected to be ready for use by the end of June 2010 (along with the co-composting facility, the drying shed). The construction of the urine storage tank and the contracts with UDDT owner represents the next milestones, which lead to the first customer served. After 3 month the first produced co-compost can be sold. MEWAREMA will attain the break-even point in the third year (Table 11). Further expanding operations are not planned.

Table 11 Major milestones

Milestones	**2010**				**2011**				**2012**				**2013**			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Construction of drying shed																
Loan for donkey cart																
Cart and drying shed ready																
Urine storage tank built																
Contracts with UDDT owners																
First customer served																
First co-compost sold																
Attaining breakeven point																

VIII. Structure and capitalisation

MEWAREMA's legal form is a cooperation. Based on the detailed analysis of MEWAREMA's projected financial results presented in the next section, the CBO projects a need for 100,000 KES (EUR 1000) in equity investment. These funds will be used to finance the construction of an urine storage tank and to avert cash shortfall in years one and two. The terms of this transaction are subject to negotiation. Funds will be used as follows:

Urine storage tank:	KES 60,000
Cash shortfall in years one and two:	KES 40,000
Total:	KES 100,000

IX. Financial Plan

The following schedules provide detailed financial projections for the years one through five of MEWAREMA's faecal matter collection, transport and treatment service. In summary, MEWAREMA expects to generate an overall operating profit of KES 7,780 in year four. Securing a positive cash flow throughout the year the distribution of UDDT-emptying plays an important role. Whereas an approximate equal distribution of UDDT-container-emptyings results in a positive cash flow of nine month in year three. An unbalanced distribution would always

result in approximately 6 month per year where the cash flow is negative. The collection and transport service on its own is not operating profitable.

Attached are the following schedules:

1. Notes and assumptions for financial projections
2. Projected income statement
3. Breakeven point
4. Scenarios

Schedule 1: Notes and assumptions for financial projections

All financial statements have been projected on a monthly basis and summarised annually.

Service revenues

Number of container-emptyings per year per UDDT

Every UDDT is equipped with 3 containers. Depending on the numbers of UDDT installed per plot, and the number of people using the UDDT, the fill up time of each faecal matter container differs from 1 1/2 month to 6 month. This allows a possible storage time of 3 to 12 month until the container needs to be emptied for reuse. Thus the number of required container-emptyings per UDDT varies from 2 to 8 times per year.

To calculate the monthly income statement a schedule of emptying (

Figure 29) was developed to simulate a realistic operation of the collection service.

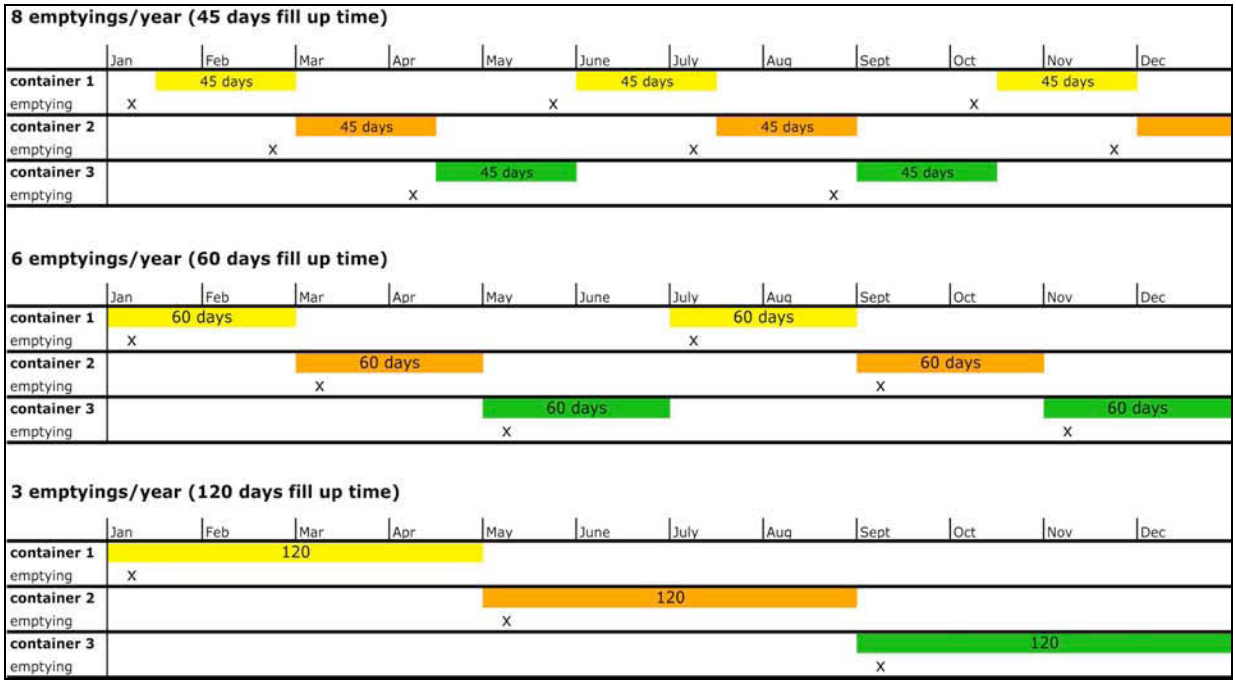

Figure 29 Schedule of emptying of faecal matter container depending on the fill up time

At present there are three customers who are willing to pay for the urine collection. Depending on the fill up time of 18 days to 90 days per urine container the emptying is required two times a year up to four times a month.

Numbers of UDDT

MEWAREMA expects an increase of four UDDTs in the third year and two UDDTs in the fourth year. Thus sales projections assume an increase in customers within five years as follows:

Table 12 Number of customers and UDDTs

Year	Number of customers	Number of UDDTs
1	9	24
2	9	24
3	11	28
4	12	30
5	12	30

The increase from 24 to 30 UDDTs within four years is a very moderate assumption in view of the fact that between 2009 and 2010 19 UDDTs have been constructed. A higher increase in new customers will of course lead to a further rise in service revenue.

Distribution of UDDT-container-emptyings

Based on the given and projected number of UDDTs per customer, the given fill up times and the schedule of emptyings the number of UDDT container-emptyings per month was projected. Table 13 presents the numbers of container emptied per month in the first year of operation. The number of containers emptied per month are the basis for the calculation of transport costs and service revenues per month. Appendix 4 presents the table in full length. The fact that not all UDDTs have been put into operation at the same time is made allowance for by assuming that three of nine customers are served for the first time in third month of operation. This allows as well an almost equal distribution of emptyings of around 11 to 15 container-emptyings per month.

Table 13 Number of container-emptyings per month, first year of operation

Customer	No. of UDDTs	Fill up time (days)	Number of container-emptyings per month per customer											
			Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	5	45	5	5		5	5		5	5		5	5	
2	2	60		2		2		2		2		2		2
3	2	180	1						1					
4	3	60	3		3		3		3		3		3	
5	4	60		4		4		4		4		4		4
6	2	60	2		2		2		2		2		2	
7	2	60			2		2		2		2		2	
8	2	120			2				2				2	
9	2	60			2		2		2		2		2	
Total no. of container-emptyings per month			**11**	**11**	**11**	**11**	**14**	**6**	**17**	**11**	**9**	**11**	**16**	**6**

For an emptying of one 50 l container there is a charge of KES 100. Based on the assumption mentioned the following revenues are projected. The faecal matter collected will be used for co-

composting in the manufacturing branch and represents therefore revenue in the form of raw material.

Table 14 Service revenues for year one to five

Year	Service Revenue (KES)	Amount of faecal matter (kg)
1	18,800	6,700
2	19,200	6,900
3	21,600	8,100
4	22,800	8,700
5	22,800	8,700

Costs of service

Payments to the two employees that will collect and transport faecal matter comprise 87 percent of cost of service. The remaining 13 percent represents other costs like donkey food, water, cleaning material and maintenance. Since wages and water consumption are calculated per working day those variable cost will rise with the number of working days needed to serve new customers in future. For the first years the cost of service are summarised in Table 15. Appendix 6 presents a monthly-based statement of service costs for year one to five.

Table 15 Costs of service first year

Costs (KES)		33,090
Wages	28,800	
Depreciation (collection cart, equipment)	0	
Other costs (donkey food, water, cleaning material, maintenance)	4,290	

Manufacturing Revenues

Based on the amount of faecal matter collected and thus available for co-composting the projected revenues as given in Table 16 are expected. A precondition is that the ready to use compost will be bought by NAWACOM at a price of 5 KES per 1 kg. Due to the duration of the composting process the first compost can only be sold after three month of the first faecal matter collection.

Table 16 Sales revenues

Year	Compost (2:1 organic waste + faecal matter) to be treated (kg)	Amount of compost sold (kg)	Revenue in KES
1	20,100	9,660	48,300
2	20,700	14,490	72,450
3	24,300	16,170	80,850
4	26,100	17,850	89,250
5	26,100	18,270	91,350

Cost of goods sold

Cost of goods sold consists only of cost of goods manufactured. Payments to the employees that will operate the co-composting comprise 92 percent of cost of goods manufactured. The remaining 8 percent represents indirect costs like, water, cleaning material and maintenance. Appendix 7 presents a monthly based statement of manufacturing costs for year one to five.

Table 17 Cost of goods manufactured year one through five

	KES	KES
Direct materials used		0
Direct manufacturing labour		57,600
Indirect manufacturing costs		4,792
Supplies (organic waste)	0	
Depreciation - plant equipment	0	
Sampling	0	
Water	960	
Maintenance	3,832	
Manufacturing costs incurred		**62,400** (rounded)

Operating costs

As indicated in the marketing plan higher marketing costs will not occur until MEWAREMA earns a profit of about 50,000 KES (500 EUR). Nevertheless there will be advertising expenses of 50 KES per UDDT from the first year. Marketing costs based on the market plan are given in Table 18.

Table 18 Advertising and promotional costs

Year	Advertising (ca. 50 KES per UDDT per year) in KES	Promotion (Demonstration site, etc.) in KES
1	1,200	0
2	1,200	0
3	1,400	0
4	1,500	(500)
5	1,500	(500)

General and administrative costs only include the supervisor salary. The supervisor controls the compliance with the necessary collection cycle and the maintenance work of the employees. Up to now no other administrative expenses are known.

Schedule 2: Projected income statement

MEWAREMA Projected Income Statement					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenues (service-branch)	**18,800**	**19,200**	**21,600**	**22,800**	**22,800**
Costs					
wages	28,800	29,400	32,400	33,600	33,600
depreciation (collection cart, equipment)	0	0	0	0	0
other costs (donkey food, water, maintenance)	4,290	4,300	4,350	4,370	4,370
Operating Profit	**-14,290**	**-14,500**	**-15,150**	**-15,170**	**-15,170**
Revenues (manufacturing-branch)	**48,300**	**72,450**	**80,850**	**89,250**	**91,350**
Cost of goods sold	0	0	0	0	0
Opening finished goods	0	0	0	0	0
Cost of goods manufactured	62,400	62,400	62,400	62,400	62,400
Cost of goods available for sale	0	0	0	0	0
closing finished goods	0	0	0	0	0
Gross margin	-14,100	10,050	18,450	26,850	28,950
Operating costs:					
marketing (advertising per UDDT 10kg compost = 50 KES per UDDT)	1,200	1,200	1,400	1,500	1,500
general and administrative	2,400	2,400	2,400	2,400	2,400
Operating profit	**-17,700**	**6,450**	**14,650**	**22,950**	**25,050**
Overall Profit (loss)	**-31,990**	**-8,050**	**-500**	**7,780**	**13,780**

The monthly income statement for year one to five is presented in appendix 5.

Schedule 3: Breakeven analysis

To calculate the breakeven point the following formula was used:

Breakeven point for output = Fixed Costs / (Unit Selling Price − Unit Variable Costs) and

Breakeven point for sales = Fixed Costs / ((Unit Selling Price − Unit Variable Costs)/ Unit Selling Price).

The wages of the co-composting-plant workers have been regarded as fixed costs since their number of working days (8 times each month) does not depend on the number of UDDTs served but on the co-composting process only. (Due to the regulation in the composting process.) Furthermore in order to be able to calculate the breakeven point against the units (kg) of compost sold, the operating loss of the service branch (collection and transportation) was regarded as direct material cost used in the manufacturing branch (co-composting). Table 19 lists different breakeven points for year 1 to year 5 since they depend on the size of operation. Further information can be found in appendix 8.

Table 19 Breakeven points

		Year 1	Year 2	Year 3	Year 4	Year 5
Selling price per unit	KES	5.00	5.00	5.00	5.00	5.00
Fixed costs	KES	67,642	67,642	67,642	67,642	67,642
Unit contribution margin	KES	3.69	4.19	4.15	4.23	4.24
Unit variable costs	KES	1.31	0.81	0.85	0.77	0.76
Breakeven point in output	**Kg**	**18,323**	**16,144**	**16,288**	**16,007**	**15,939**
Breakeven point in sales	KES	91,618	80,722	81,442	80,035	79,699

From the breakeven point calculation it follows that approximately 16,300 kg of compost have to be sold to break even. This amount can be manufactured if 165 containers are emptied per year, which is an equivalent to between 28 and 29 UDDTs served (with an average fill up time of 70 days per container.) Figure 30 illustrates the calculated breakeven point (quantity of output ca. 16,300kg) where total revenues and total costs are equally derivated from the year 4 figures in Table 19.

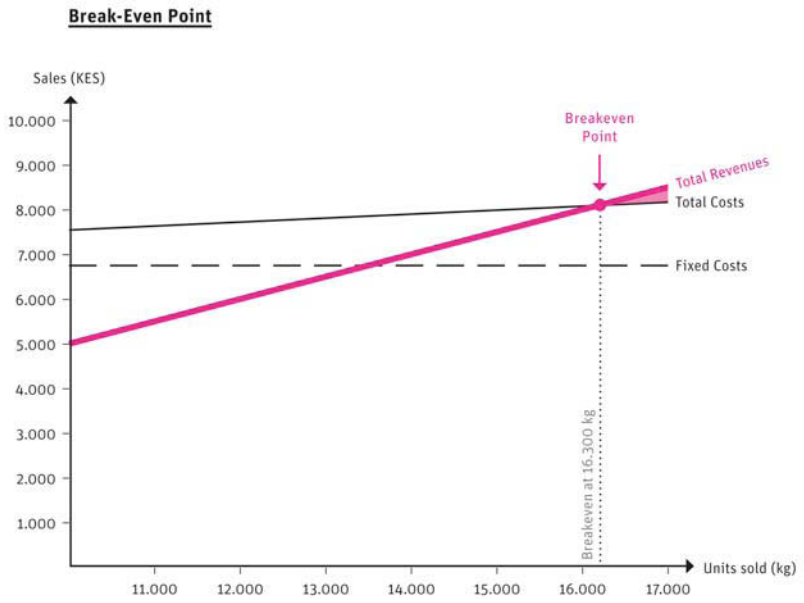

Figure 30 Breakeven point

Schedule 4: Scenarios

Different distribution of UDDT-emptyings per month

The performance of MEWAREMA depends on the monthly distribution of UDDT-emptyings. An equal distribution i.e. 11 emptyings each month is due to the varying given fill up times of UDDT-containers not possible. This influences the required working days and therefore the overall profit as well as the number of month per year where positive cash flow is attained. The above presented projected income statement (schedule 2) is based on an almost equal distribution of UDDT-emptyings (described in schedule 1) Table 20 presents the projected income statement of a more unbalanced UDDT-emptying distribution scenario which indicates the negative influences on the overall profit.

Table 20 Income Statement unbalanced distribution

MEWAREMA projected income Statement *	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues (service-branch)	**19,200**	**19,200**	**21,600**	**22,800**	**22,800**
Costs					
wages	27,600	27,600	30,600	32,400	32,400
depreciation (collection cart, equipment)	0	0	0	0	0
other costs (donkey food, water, maintenance)	4,270	4,270	4,320	4,350	4,350
Operating Profit	**-12,670**	**-12,670**	**-13,320**	**-13950**	**-13950**
Revenues (manufacturing-branch)	**50,400**	**72,450**	**80,850**	**89,250**	**91,350**
Cost of goods sold					
Opening finished goods	0	0	0	0	0
Cost of goods manufactured	66,060	66,060	66,060	66,060	66,060
Cost of goods available for sale	0	0	0	0	0
closing finished goods	0	0	0	0	0
Gross margin	-15,660	6,390	14,790	23,190	25,290
Operating costs					
marketing (advertising per UDDT 15kg compost = 50 KES)	1,200	1,200	1,400	1,500	1,500
general and administrative	2,400	2,400	2,400	2,400	2,400
Operating profit	**-19,260**	**2,790**	**10,990**	**19,290**	**21,390**
Overall Profit (loss)	**-31,930**	**-9,880**	**-2,330**	**5,340**	**11,340**

Figure 31 illustrates the difference in overall operating profit resulting from different distribution of UDDT-emptyings on identical boundary conditions (number of customers and UDDT per year, selling price, etc.).

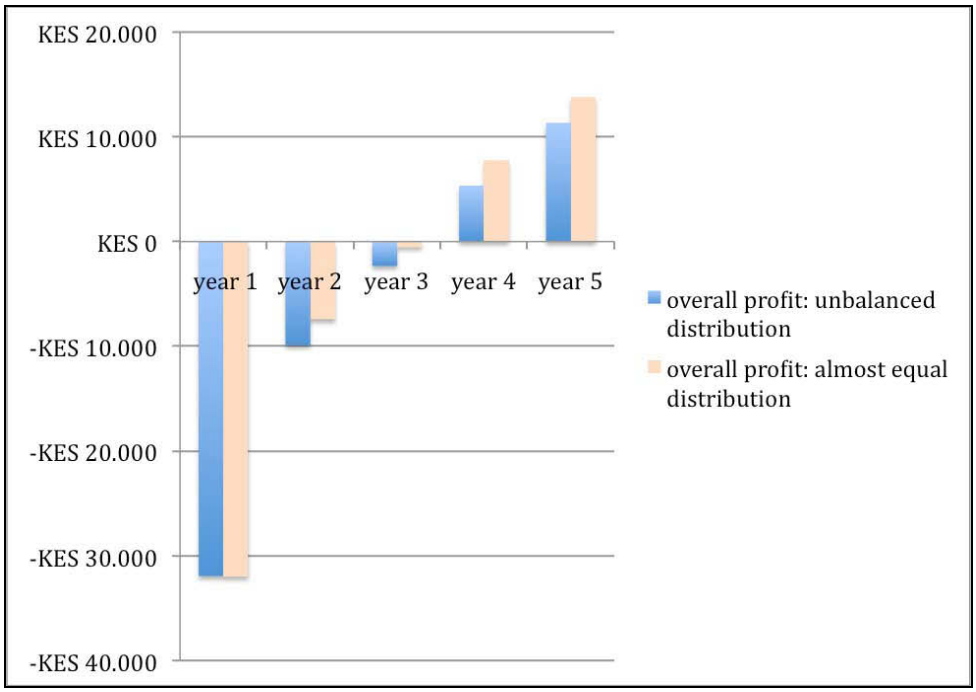

Figure 31 Difference in overall operating profit resulting from an unbalanced and almost balanced distribution of UDDT-emptying per moth for year one to five

Scenario 1: Increase in customers

In this scenario an increase in customers of one per year (with at least 2 UDDT each and a fill up time of the faecal matter container of two month) is assumed. Hence the number of UDDTs served sums up to 32 in five years. In comparison to the moderate customer increase (underlying the primary calculation) of four UDDTs in the third year and two UDDTs in the fourth which sums up to 30 UDDT served in year five. Figure 32 illustrates that an operating profit of KES 1,600 could already be reached in year three.

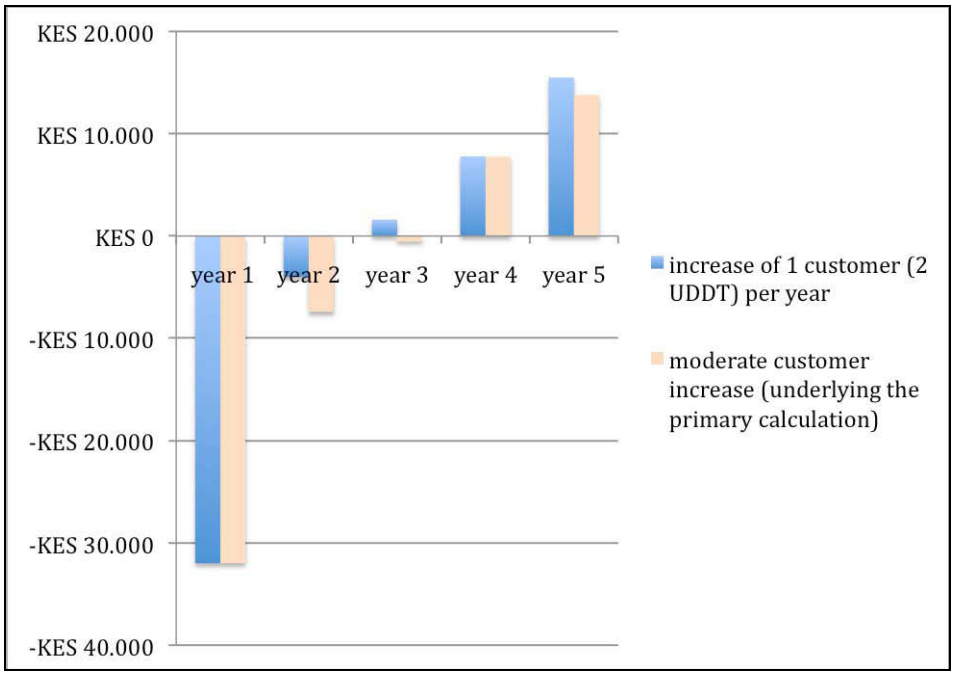

Figure 32 Scenario 1: Differences in operating profit corresponding to different customer increase

Scenario 2: Increase in selling price of compost

More optimistic scenarios presented by means of breakeven points in Figure 33 could be realised if:

I. 1 kg compost would have a selling price of 6 KES (instead of 5 KES). This would lead to a breakeven point of 13,200 kg compost. Thus an operating profit of 7,500 KES could already be reached in year two with 24 UDDTs served.

II. A selling price of 7 KES per 1 kg compost could be attained. Resulting in a breakeven point of 11,000 kg compost. Thus the operating loss of the first year could be reduced by 64 % to -11,500 KES and in the second year a operating profit of 22,000 KES could already be generated.

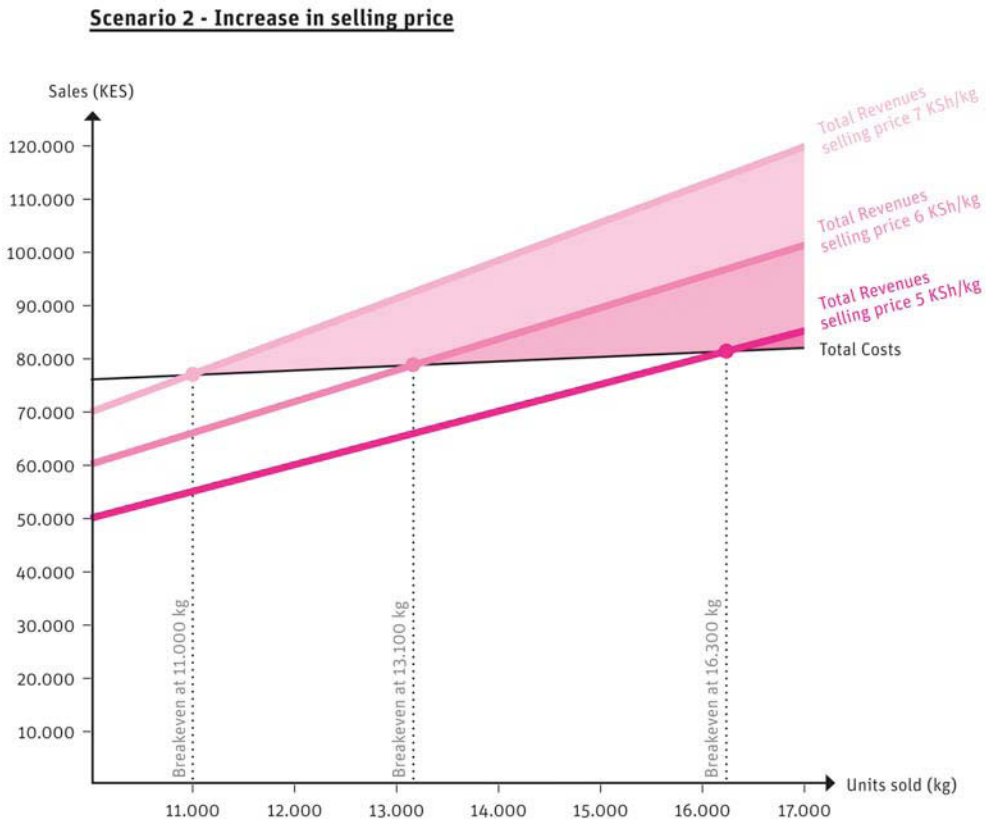

Figure 33 Scenario 2 - Increase in selling price of compost resulting in different breakeven points

Scenario 3: Subsidy by the Municipality

The Municipality Council of Nakuru (MCN) is responsible for sanitation and is highly subsiding the sewerage system in wealthier estates. In this scenario MCN subsidies the faecal matter collection service with 300 KES per UDDT.

Resulting in a break-even point at 14,100 kg compost sold (instead of 16,300 kg). Thus an operation profit could be already generated in year 3 with 26 UDDTs.

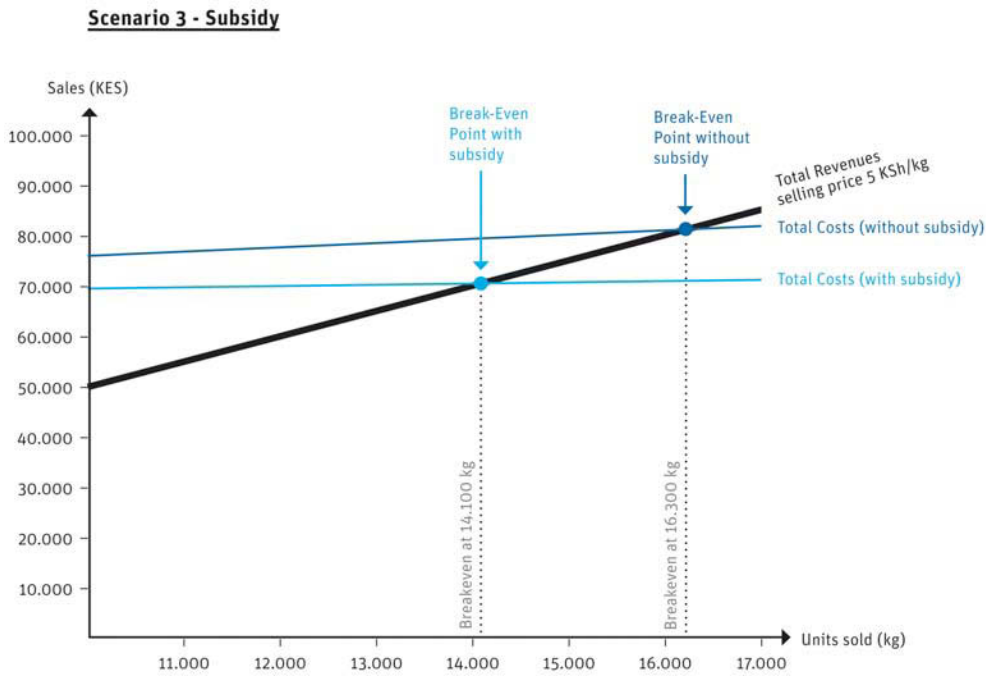

Figure 34 Scenario 3 – subsidy by the municipality resulting in different breakeven point

X. Risks

General risks

General risks that are specific to Kenya and might have negative influence on the performance of MEWAREMA are:

- Natural disasters:

  The data related to disasters that have occurred between 1982 and 2008 in Kenya have been analysed by PreventionWeb. The disaster statistic indicates that droughts, epidemics and floods are the most common disasters and have a frequency of occurrence as presented in Table 21.

Table 21 Average Disasters per year in Kenya (PreventionWeb, 2010)

	Average disaster per year	Affected people per event
Drought:	0.33	4,033,500
Earthquake:	0.07	...
Epidemic:	0.96	264,100
Flood:	1.04	73,100

Floods caused by heavy rainfall can affect the composting process since moisture content and temperature are the main influencing factors in the process. Droughts might lead to an increase in water price, which would have an influence on the indirect costs of MEWAREMA.

- Political risks:

  According to the latest Kenya Business Leaders Confidence Index by Synovate, perceived political risks have been on an upward trend. The study, conducted in March 2010, reveals that currently most business leaders in Kenya (76 per cent) consider political instability to be the main risk to their businesses. Over 27 per cent of the country's business leaders stated that competition is the major risk facing them while 18 per cent think that the major risk is posed by cheap imports and poor state of roads and communication network. Despite the country being set for elections before the end of the year 2010, 95 % of the businesses think it will not have a major impact on their operations. (Olouch and Kapchanga, 2010)

Business risks

Risks that are specific to the business of MEWAREMA are the following:

- Product risk:

  The compost produced can fail to be hygienically safe due to failures within the composting process. Those malfunctions can be caused by neglection of the treatment work, vandalism or unexpected shortage of raw materials (organic waste). To avoid this a high level of management is necessary that has to be controlled by the supervisor.

- Compliance with safety regulations:

  The risk that workers not wearing proper safety tools (gloves, protection masks and boots) have to be considered. In such situations the supervisor must be held accountable for violating regulations.

- Market risk:

  The organic fertilizer market can develop differently than expected (i.e. reduction of demand). This might occur if the government subsides chemical fertilizer even more than presently. To counter this development described marketing strategies will not be disregarded.

- Economic risk:

  Payment policies have to be handled strictly enough to avoid getting behind the cash flow curve. Possible deficits could be financed through MEWAREMA's profit from its solid waste collection branch. Since the produced compost is exclusively sold to NAWACOM the operating profit highly depends on NAWACOM's performance. Thus further compost buyers have to be identified to counter the dependence on NAWACOM.

- Political support of ecological sanitation:

  There is the risk that capacity development at local, regional and national level concerning ecological sanitation has not yet taken place to an extend that would guaranty full support of the sanitation system and the work of MEWAREMA. Hereby the law actually prohibiting the use of excreta as fertilizer needs to be mentioned. However the Government launched a „2007-2015 National Water Services Strategy" (NWSS) that aims to increase access to improved, safe sanitation to 77.5 % for urban residents and 72.5 % for the rural population. The NWSS realised that such an increase cannot be achieved by conventional sewerage systems, particularly as the recycling of effluent is critical. Therefore NWSS promotes ecological sanitation options wherever this concept is acceptable to communities (Onyango and Odhiambo, 2009).

5.2.3 Cost and Benefit Analysis

In order to verify the first hypothesis this chapter will summarize the cost and benefits generated by the proposed human waste management system. To measure health and environmental benefits monetarily and to calculate the avoided organic waste disposal costs far more information would be required, which could not be gathered in the course of this thesis. Costs and benefits affect the CBO MEWAREMA, UDDT owners and users as well as the community and municipality.

Costs

MEWARMA:

The operating loss in the first three years of operation (calculated in the business plan) can be regarded as costs, which sum up to 40,500 KES. In case NAWACOM fails to buy the compost produced this costs will rise immediately since revenues from compost selling highly influence the operating profit.

UDDT-OWNER:

Cost incurring on the part of the UDDT owner depend on the number of UDDTs per plot and the number of tenants using them. Moreover higher cost incur if an UDDT owner uses the service of faecal matter and urine collection (instead of only faecal matter collection). Thus costs for UDDT-owner vary from 50 KES to 500 KES per month (respectively 600 KES to 6,000 KES per year). 6,000 KES per year occur at a plot where 28 households (112 people) are served by 5 UDDTs and the owner is willing to pay 400 KES per month for the urine collection in addition to the faecal matter collection. However the costs for the faecal matter collection remain under 2,000 KES per year for all other current UDDT-owner on plots where 3 to 30 people are served and beneath 1,000 KES per year for 6 out of 9 UDDT-owner.

COMMUNITY/ MUNICIPALITY:

No costs occur for the municipality/community unless the municipality finances demand creation through awareness rising campaigns for the use of compost and a health education program to promote the use of resources-oriented sanitation facilities.

Benefits

MEWAREMA:

At least two employment opportunities are created. The labourer can earn a minimum of 3,200 KES a month (respectively 300 KES a day and 12 working days). An increase in customers will lead to further increase of salary and/or employment opportunities.

MEWAREMA diversifies its operation since it is already engaged in solid waste management and composting of market waste. Diversification reduces the risk of dependence on one individual market and has the potential to balance the overall operating profit of a business.

If urea in urine could be extracted (ongoing research) a new market for the use as organic fertilizer might develop. In that case MEWAREMA would have an additional source of revenue by selling collected urine. A resulting increase in profits could be used for an increase in wages, marketing, etc.)

UDDT OWNERS/USERS:

Improved health through clean sanitation facilities.

The toilet structure is permanent hence it saves space on the plot in comparison to abandoned pit latrines.

Economic benefits arise from the fact that toilets can be emptied, without the aid of a vacuum truck. According to MÜNCH (2009) this can present significant cost savings for UDDT owners in the long run. If the UDDT owners use the compost received in return for using the collection service (10kg per year per UDDT) further benefits can arise mainly from increased yields of garden and field crops.

The rise in property value and intangible benefits of dignity, privacy, security (in comparison to open defecation) and social status represent further benefits (SIJBESMA et al., 2008).

COMMUNITY/ MUNICIPALITY:

The community profits from a sustainable human waste management system since it improves the health and living conditions of the residents and reduces the environmental pollution (especially groundwater pollution).

The improvement of the state of health of the residents leads to:

- Cost savings on medical care on the part of the residents;
- Increase of attendance of pupils in school;
- Increase of productivity of the residents.

The reduction of environmental pollution contributes to the protection of the Lake Nakuru National Park, which is bordering the urban area of Nakuru. This park attracts 20,000 visitors per month and is therefore an important source of income for the municipality (ROSA, 2010).

The treatment of faecal matter is accomplished by co-composting thus the benefits of composting have to be considered similarly.

According to MCDOUGALL et al. (2001) separation and composting (or biogas production) of organic waste represents an opportunity to reduce the quantity of waste entering landfills by up to 50 % (by weight) in developing countries. Hence it extends the life time of disposal sites (MEDINA, 2005).

Adequate treatment of organic waste will furthermore reduce environmental pollution and health problems by removing the mayor source of leachate, odours and food for disease carriers (flies, birds, rodents, etc.) (MCDOUGALL et al., 2001) and preventing generation of methane hence reducing the contribution to global warming (MEDINA, 2005).

Moreover composting produces a useful product (soil conditioner and fertilizer used in agriculture, parks, horticulture, etc.) and conserves natural resources. By promoting the use of organic fertilizer (made of compost or urine) instead of chemical fertilizer the government could save the money spend on chemical fertilizer subsidies.

Additionally, “increased food production in poor communities through better availability of fertilisers improves food security and nutrition” (MÜNCH, 2009, p.7).

The municipality saves collection, transportation and disposal costs through the work of MEWAREMA. However, those costs are theoretically since the municipality never offered a similar service in these estates.

Like stated above the economic benefit resulting from the benefits mentioned is almost impossible to quantify. Major research to get the required data would be necessary including many valued and uncertain events. Therefore it is waived to compare the costs and benefits on a monetary basis. However one might be allowed to conclude that most of the benefit is to the environment and the health of people and preponderates the cost.

5.3 Verification of hypothesis

5.3.1 Profitability of the resources-oriented human waste management system

The suggested community-based, resources oriented human waste management system has been presented in detail in the preceding chapters. Based on the results of the business plan and the comparison of the cost and benefit the first main-hypothesis:

H.I: The operation of a resources-oriented human waste management system is profitable.

can be verified by confirming the sub-hypotheses.

Sub-hypothesise H.I-1 is corroborated albeit benefits could not be expressed in monetary terms (and consequently the equation “benefits / costs ≥ 1” can not be solved) it could be concluded that the benefits exceed the costs.

H.I-1	The sub-hypothesis H.I-1 is accepted The cost-benefit analysis is positive. ▪ The benefits exceed the costs.

Sub-hypothesise H.I-2, is corroborated since in the course of the business plan a projected income statement was elaborated followed by an breakeven analysis with positive results.

H.I-2	The sub-hypothesis H.I-2 is accepted. A potential profitability can be calculated by using a breakeven analysis. ▪ The unit-selling price exceeds the unit variable cost.

At present 24 UDDTs can be served by MEWAREMA in the catchment area. The breakeven point analysis revealed that approximately 29 UDDTs need to be served in order to receive sufficient faecal matter to gain a cost-covering amount of revenues from co-composted faecal matter. MWANZIA (2010) working for the microcredit program to finance the capital investment cost of sanitation facilities in Nakuru, confirmed that the demand will grow not just in London and Hilton but in other low income settlements within the municipality. Furthermore the Municipal Council of Nakuru will also promote the same technology after ISSUE-2 program through another programme. In 2010 two additional landlords in the two estates applied for a microcredit to build UDDTs in future. Consequently sub-hypothesise H.I-3, is corroborated.

H.I-3	The sub-hypothesis H.I-3 is accepted. The demand of toilet facilities meets the number of toilet facilities required to breakeven. ▪ Approximately 29 UDDTs need to be served in order to receive sufficient faecal matter to gain a cost-covering amount of revenues from co-composted faecal matter. ▪ The Municipal Council of Nakuru and a microcredit programme support the construction of UDDTs in Nakuru.

Market research on the demand for compost in Nakuru is not available. However upon agreement with NAWACOM the calculations were made under the assumption that NAWACOM purchases 100 % of the produced compost. Accordingly the sub-hypothesis H.I-4 is accepted.

H.I-4	The sub- hypothesis H.I-4 is accepted. The demand of compost meets the amount of compost sold required to breakeven. ▪ It is assumed that NAWACOM purchase 100 % of the compost produced.

The corroboration of four out of four sub-hypothesis justifies the decision to accept the subordinate first main-hypothesis as verified.

H.I	The main-hypothesis H.I is accepted. The operation of a resources-oriented human waste management system is profitable.

5.3.2 Human waste management in the form of a social business

Based on the results presented in the business plan and the confirmation of the first main hypothesis the second main hypothesis:

H.II: MEWAREMA is a social business.

can be verified by testing the framed sub-hypotheses. In this case the sub-hypothesis correspond to the principles of a social business.

H.II-1	The Sub- hypothesis H.II-1 is accepted. It aims at solving social and environmental problems. ▪ MEWAREMA aims at improving the health and living condition of people and at reducing environmental pollution.

H.II-2	The Sub- hypothesis H.II-2 is accepted. It is in every respect a economic-business - financial sustainable ▪ MEWAREMA is in every respect a economic-business - financial sustainable ▪ The projected income statement indicates profitability as from year 3 of operation. ▪ The first main hypothesis is corroborated thus financial sustainability in future is possible.

H.II-3	The Sub- hypothesis H.II-3 is accepted. Invested capital is repaid after time without dividend payment. ▪ Besides a microcredit, with an annual interest rate of 9 %, no investors are involved.

H.II-4	The Sub- hypothesis H.II-4 is accepted. Profits are reinvested into the business for expansion and improvement. ▪ Profits will be used for marketing, diversification or an increase in wages.

H.II-5	The Sub- hypothesis H.II-5 is accepted. Workforce gets market wage with better working conditions. ▪ Trained labourers are equipped with protection gear and earn 300 KES. per day in comparison to the minimum wage of 221 KES a day. ▪ Thus wages of MEWAREMA's labourer ≥ minimum wages in Nakuru and protection clothing is available and used

In summary the confirmation of five out of five sub-hypotheses based on the presented results lead to the conclusion: MEWAREMA fulfils the principles of a social business and can therefore be considered as social business. Hence the second main Hypothesis is verified.

H.II	The main-hypothesis H.II is accepted. MEWAREMA is a social business.

As described in chapter 2.6, YUNUS (2010) distinguishes between two types of social business, thus MEWAREMA can be considered as a mixture of both types since it is owned by the poor community and also pursues only social objectives.

6. Discussion

6.1 Limitations of the business plan and the included calculation

The presented income statement is a projection based on assumptions, consequently there is no guarantee that MEWAREMA's performance will develop as calculated. Furthermore no comparable business could be found that operates under identical conditions. However similar community based small-scale businesses engaged in solid waste management perform well after they have received financial support in the start-up phase (GENESIS, 2009). As mentioned, a collection and transport service for separated excreta was implemented successfully in Arba Minch, Ethiopia. However in the run-up to the implementation extensive awareness raising campaigns have been accomplished to stimulate a market for urine and compost. This led to the willingness to pay for urine and compost on the part of the farmers in urban hinterland (KASSA, 2010).

Regrettably MEWAREMA's historical financial data could not be gathered this would have helped to understand the history of the CBO in a financial format.

Reliable data on the compost demand of farmers in the Nakuru region have not been available and this presents the main deficit in the business plan.

A further restriction is the fact that ideally a business plan is written by the business owner itself. However, in this case the business plan was chosen as an adequate mean to determine potential future developments, needs and risks. Moreover, the members of MEWARMA do not have access to internet thus indispensable data research via internet would hardly have been possible. In addition it took two month to develop the business plan and it is questionable if the leaders of MEWAREMA could have spent that time besides their day to day work.

Unfortunately the only means to prove whether the business will operate profitable in reality, is to take the risks and run the business. Therefore one should not get discouraged by what is revealed in the business plan but see the opportunities beyond.

6.2 Identified challenges

Based on the results of the business plan the following challenges could be identified:

Economics:

> The identified cash shortfalls respectively the operating loss of 40.500 KES. (ca 405 EUR) incurring in the first three years needs to be covered.
>
> Since revenues from compost sales might be seasonal and revenues of the service branch are not cost-covering, it is possibly difficult to maintain a positive cash flow throughout the year. Ideally the regular income of MEWAREMA's solid waste branch can balance those negative monthly cash flows.
>
> Revenues arising mainly from compost sales. Given that the produced compost is exclusively sold to NAWACOM the operating profit highly depends on NAWACOM's performance. Thus further compost buyers have to be identified to counter the dependence on NAWACOM.

Required resources:

> An urine storage tank has been found to be indispensable in order to meet WHO guidelines (storing urine for one month before reuse) and to allow the use of collected urine in the co-composting process. A urine storage tank is not available yet thus financing needs to be provided to construct and maintain one. The capital investment cost of a storage tank of a capacity of $10m^3$ are considered to be 6,000 KES (600 EUR).

Organic waste supply:

Up to now MEWAREMA collects organic waste from the dump site. A more effective and hygienically safe method has to be developed. One option is the implementation of organic waste transfer stations, consisting of closable containers, in populated town areas and on markets. The effective usage of such containers depends of course on the public awareness about the benefits.

Marketing:

A sanitation business relies on there being a market for the service and products. The business plan lacks information on profound market analyses: how many potential customers are within reach of the business and what compost could be sold for to other customers than the bulk buyer. Identifying this data would help in developing specific marketing strategies. Moreover demand creation programs (e.g. organic demonstration farm) will stimulate the market.

Demand creation:

One process that influences the sustainability of the O&M service is the demand creation for sanitation service, sustainable sanitation facilities, compost and urine. However community-based O&M services have no means to claim demand creation support from the municipality or NGOs, therefore CBOs should try to generate the demand by themselves. Especially in Kenya where the municipality is likely to be corrupt (TRANSPARENCY INTERNATIONAL, 2009) a community-based O&M services should be as independent from the municipality as possible in order to attain sustainability. Certainly it needs the support of the municipality regarding regulations and licensing of their service but beyond that CBOs in low-income areas cannot expect more. One example of how communities can generate demand for sanitation facilities by means of social pressure, offers the “community-led total sanitation” concept (chapter 2.5.2). However the presented study of this concept points out that small-scale enterprises (respectively community-based organisation), which offer O&M services, lack the financial means to perform awareness rising campaigns and health education. As a result MEWAREMA will have to search for financial support.

Further compost purchasers:

Efforts should be made to identify further compost purchasers. The calculation showed that an increase in the selling price of compost would have a significant impact on MEWAREMA’s overall profit thus any new customer acquired, willing to pay more than 5 KES per kg compost, should be regarded as success on the way to achieve sustainability. Amongst others the municipality presents a potential customer that could use the compost in the maintenance of public green spaces.

Up-scaling:

An up-scaling of this system might be possible in combination with related public information and education programs in estates featuring similar basic conditions (e.g. insufficient water supply, unfavourable soil structure for pit latrines, etc.) preconditioned there is sufficient demand for compost and urine to recover costs. As recommended by SOHAIL et al. (2005) the municipality or alternative service providers should develop guidelines for the execution of the management of separated human excreta from UDDTs in conjunction with local communities. Additionally should verification practices respectively control mechanisms be implemented.

6.3 Opportunities

Besides the challenges discussed above, the results also indicate the opportunities of the community-based, resource-oriented human waste management system. Especially the combination of faecal matter treatment and organic waste composting has the potential to significantly reduce environmental pollution and to help reduce residents health risks. Further important advantages are the created job opportunities and due to the community-based concept the money paid (on the part of UDDT owner for the service of faecal matter collection and transport) as well as the revenues from compost sales stay within the community.

The presented concept scheme (Figure 23) indicates the value of profit margin available within the whole value chain. However only a certain value of profit margin is available to MEWAREMA. A higher proportion of the total margin could be attainable if MEWAREMA's market position is strengthened and hence negotiating power is gained. In addition cooperation of the stakeholder to improve their efficiency and to reduce their costs could lead to a higher total margin to the benefit of all.

6.4 Negative impacts on potential improvements

This community-based human waste management system, as well as the already implemented solid waste management system in the two estates, aim to improve the sanitation, health and living conditions of the residents. However, as long as the adjoining open dump site (in 300 meter distance to the estates Hilton and London) remains in its inadequate condition the health benefits generated are jeopardized. Members of MEWAREMA are directly affected by those harmful conditions since the drying shed for composting is on the dump site.

Waste separation, at least of organic waste, should be enforced and organic waste collected should be transferred to MEWAREMA's co-composting plant. Assuming that the municipality is not capable in providing an adequate organic waste disposal service one possibility could be the implementation of a small business undertaking the collection of organic waste from hotels and markets. Such a business could for example be operated by scavengers living from and around the dumpsite.

6.5 Comparison to a similar sanitation system in Arba Minch, Ethiopia

In the case the challenges discussed above will be met, the sanitation system could resemble the "urine diversion sanitation system option" scheme developed in the course of the ROSA project for Arba Minch, Ethiopia (Figure 35). Whereby the separately collected urine is transported from households to a central urine storage tank where it is stored for pathogen die-off and then transported to an urban agricultural area for re-use. The faeces are transported to co-composting plant to be co-composted with organic waste collected from households and markets. The compost produced is used as fertilizer and soil conditioner in urban agriculture in the town and the surrounding agricultural areas.

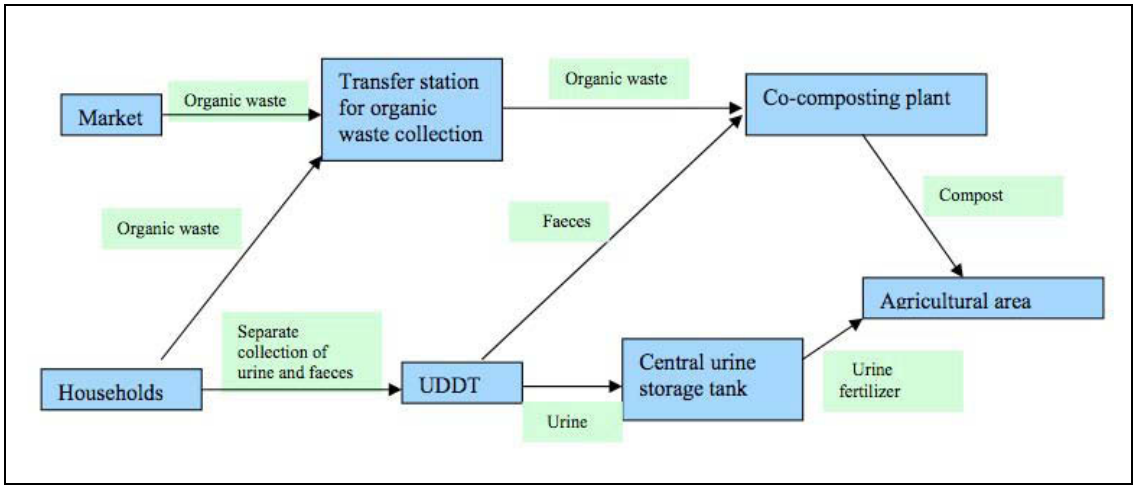

Figure 35 Urine-diversion sanitation system in Arba Minch, Ethiopia (MINDACHEW YEMANEH, 2009)

The transfer station for organic waste collection consist of one organic waste container with a capacity of 10 m and a considered unit capital investment cost of 10,000 ETB (Ethiopian Birr, i.e. about 600 EUR) (EPD, 2005 in MINDACHEW YEMANEH, 2009). One transfer station is assumed to be installed per four hectare of populated town area (1,067 ha) and five transfer stations will be established at the market places. The capital investment cost of a 50 m^3 concrete central urine storage tank is considered as 35,000 ETB (about 2100 EUR).

The cost analysis reveals that the O&M cost of this system is very high (higher than for all other compared sanitation options) due to the fact that a dump truck is assumed to be used for collecting the separately collected urine from households to the central urine storage tank, faeces from households to the co- composting plant, organic waste from transfer stations to the co-composting plant and compost from co-composting plant to the agricultural area (in 10 km distance). Furthermore it shows that urine sale can contribute significantly to the cost recovery whereby the selling price is determined based on the nitrogen content of urine and equivalent cost of mineral fertilizer containing the same amount of nitrogen (7.6 Birr (0,46 EUR; 46 KES) per kg) (MINDACHEW YEMANEH, 2009).

The high O&M cost, caused by the scale of the system respectively the required utilisation of a dump truck, emphasises the advantage of the suggested community-based system in Nakuru where transportation is exclusively carried out by an donkey cart and the composting plan is situated in short distance to the served estates. The ability of the urine sale to contribute significantly to the cost recovery emphasises once more the imperative to establish a market for urine and compost in Nakuru.

6.6 Further sustainable sanitation options

A cost analysis of different resources oriented sanitation options for Arba Minch town, Ethiopia (MINDACHEW YEMANEH, 2009) revealed that although a market for compost and urine is established, revenues from biogas produced in anaerobic digester exceed those from compost and urine sale. However the household sanitation facility in the suggested anaerobic digester sanitation system consists of pour-flush toilet. Therefore this option is not applicable in the water scarce estates of Nakuru. Nevertheless biogas production from human waste would be favourable in Nakuru due to its potential of reducing deforestation, which is an enormous problem in the Nakuru region. According to OTIENO (2005) biogas generation can be used as a strong demand driver to promote sustainable sanitation options respectively the approach of reuse of waste streams. Its immediate value and impact to the user's day-to-day energy needs represents its main advantage. However, it is characterized by relative high installation costs, user involvement and low robustness (OTIENO, 2005). This option has not been tested in the course of the ROSA project in Nakuru thus the feasibility of this option in Nakuru is unknown.

6.7 Social sanitation business

The spreading of social sanitation businesses is desirable since the concept of social business in general presents a new approach to fighting poverty and to solve social and ecological problems. Profit is reinvested in the business and workforce get at least the minimum wage and work under improved conditions including wearing protective clothing, this is especially favourable in the harmful field of sanitation. Moreover this ensures that services are offered and maintained at an adequate standard.

MEWAREMA can be considered as a social business this raises the question of the benefits of attaining the social business status. Besides the positive consequences related to the work of a social business an important issue is the fact that numerous networks and organisation, which support especially social businesses, exist worldwide. Consequently raising funds or different forms of support might be easier. One example is the “betterplace Foundation” which operates “betterplace.org”. A global internet platform that enables social projects to look for support and likewise individuals, organisations or companies to find projects that they can support. Betterplace guarantees that 100 % of the donation is forwarded to the project. In exchange the project and the people who benefit from it have to be presented and the project process needs to be regularly reported (BETTERPLACE, 2010).

7. Summary and Conclusion

Summary

One of the main reasons of the failure of sanitation projects is the lack of sustainable operation and maintenance. With regards to decentralised resources-oriented sanitation systems, in particular the use of Urine Diversion Dry Toilets (UDDTs) in low-income peri-urban areas, available literature referring to sustainable operational concepts is very limited. The focus of this thesis was to answer the following questions; Firstly, how can a collection, transport and treatment service of separated human waste be offered by a community-based organisation in peri-urban estates in Nakuru; Secondly, can a community-based, resource-oriented human waste management system in Nakuru be operated cost-effective; And thirdly, does the community-based organisation (CBO) fulfil the objectives of a social business. The results of the present thesis should serve the practical application in Nakuru and ultimately contribute to the success of community-based, resources-oriented sanitation systems by theoretically proving that economic sustainability is attainable.

The starting point of the thesis is the ROSA project. In the course of the ROSA project UDDTs have been implemented in a peri-urban area in Nakuru. Subsequently several landlords have replicated UDDTs on their own plots with the financial support of a microcredit program offered in Nakuru. In addition a CBO could be identified, which was willing to collect, transport and treat the fermented faecal matter from UDDTs. This CBO named MEWAREMA has been involved in solid waste management and composting market waste so far.

The developed operational concept anticipates that the collection of fermented faecal matter from UDDTs (equipped with movable containers) is conducted manually and the transport is carried out by means of a purpose made donkey cart. The secondary treatment of the fermented faecal matter is accomplished through co-composting of faecal matter and organic waste at a composting plant in close distance to the served estates. The produced compost will be sold to the only organic fertilizer manufacturer in Nakuru. In order to convince the UDDT owner to utilise the new collection and transport service and the UDDTs appropriately it is intended to remunerate them with 10 kg of compost per UDDT per year. (As soon as the business is generating operating profit this amount can be increased.) Since all UDDT owners stated that they are willing to use the compost in their own gardens this incentive would additionally lead to promotion the use of compost in Nakuru. The sale of urine was not considered since at present Nakuru lacks a market for this resource. Most of the implemented UDDTs are equipped with an overflow to a soak pit avoiding the risk that urine container are emptied to roadside ditches. However, at present three UDDT owners are willing to pay for the collection of urine hence this urine will be collected and transported to the composting plant where it is used to enrich the compost and to regulate the moisture content. Consequently the CBO MEWAREMA is now in need of an urine storage tank.

In order to verify the potential profitability, related information and relevant cost data were gathered in a field study in Nakuru in November 2009. Based on this data the elaboration of a business plan including a projected income statement and a breakeven analysis was reasonable. The results of the income statement indicate that under the given conditions profitability could be attained as from the year three of operation. Financial support is therefore required to cover the operating loss of approximately 40,000 KES (400 EUR) in the first three business years. The breakeven analysis revealed that an increase in the selling price of compost (from 5 KES to 6 KES or 7 KES per kg compost) would have a significant influence on the overall operating profit and leads to attained profitability already in the second business year.

The best way to obtain a better selling price of the compost is demand creation however demand creation cannot be accomplished by the CBO alone. To receive support from the municipality in this matter would be highly favourable and according to the municipality's efforts to reduce environmental pollution. However, in case the municipality does not have the capacity to promote the use of compost and urine other facilitators and funds have to be identified.

The third research question refers to the option to run the human waste management system in form of a social business. It could be proved that the CBO MEWAREMA in Nakuru fulfils the principles of a social business. The installation of social sanitation businesses is preferable since it guaranties amongst others that profit is reinvested in the business and labourer get at least the minimum wage and work in compliance with hygiene and health regulations. Moreover, in long term it operates without financial subsidies since it is economical sustainable.

In order to up scale this sanitation concept the municipality or alternative responsible utilities should develop guidelines for the safe collection, transport, treatment, and reuse of separated human excreta from UDDTs in cooperation with the local community. Additionally control mechanism should be implemented.

Conclusion

From the results of this work it can be concluded that a community-based resources-oriented human waste management system for Nakuru can be set up and operated profitable as a social business. The pre-conditions for a sustainable human waste management system are:

- Demand for sustainable sanitation facilities and O&M service among the inhabitants of low-income peri-urban areas.
- Affordability of, and access to sources of finance to cover capital investment cost of UDDTs.
- UDDT owner/user use UDDTs appropriately and are willing to pay a low service charge for the container emptying.
- The sanitation service business/organisation is community-based leading to intern, self-established control mechanism and keeping the profit and employment in the community.
- Affordability of, and access to sources of finance or subsidies to cover capital investment cost of equipment (e.g. donkey cart, drying shed) necessary to produce hygienically safe compost.
- Labourers are trained in maintaining UDDTs, handling human waste and O&M of a co-composting plant.
- Quality control (hygienic harmlessness) of the compost produced is guaranteed.
- Demand for compost exists or can be created in near future.

8. Outlook

The following issues and upcoming questions could be subject to further research. In the field of demand creation and municipality support it would be of interest to identify

- Whether municipal officers have the resources to engage in public awareness and education activities;
- The cost of awareness rising campaigns and the promotion of compost and urine;
- Where alternative resources of support can be found.

Furthermore a profound market research concerning the use of fertilizers by small-scale farmers and others would be very helpful in improving MEWAREMA's marketing strategies.

In the event that the presented human-waste management concept is replicated, the municipality should develop regulations as well as control and sanction mechanisms to ensure that preventive health and hygiene measures are taken. This should include a quality manual compiled by the organisation, the responsible authority and experts.

Regarding future operation and maintenance of installed sanitation and treatment facilities additional research could include the following questions.

- Do the source separated human waste streams get the planned and necessary treatment to prevent health and environmental risks?
- Which negative impacts does an inappropriate use of UDDTs, including an improper disposal of separated human waste, have in the worst case?
- If in future the operation and maintenance of the sanitation and treatment facilities are functioning sustainably the following questions would be of interest.
    - Which rules did the organisation impose on itself to have the ability to operate successfully?
    - Which surveillance and sanction mechanisms are in place?
    - Which conflict resolution mechanisms are in practise?
    - Are the rules adaptable to future developments e.g. a considerable increase in UDDT user accompanied by an enlargement of the catchment area?
    - Does the municipal authority accept the self-imposed rules?

Related to the use of UDDTs in Nakuru it would be interesting if UDDTs have become widely accepted after a couple years.

In the area of technical research and development the question, how micropollutants can be eliminated when using UDDTs could be investigated.

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Appendix 1

To-do list for operation and maintenance of UDDTs

To-do list for operation and maintenance taken from „Technology review "Urine-diversion dehydration toilets"“ (MÜNCH, 2009)

- Before the first use, cover the vault floor with a 3 cm thick layer of dry powdered earth to absorb moisture from the faeces and to prevent faeces from sticking to the floor.
- Preferably keep two containers on the latrine platform, one full with dry absorbents (sawdust, peat moss, dry soil, ash, etc.) and a shovel or a small bowl, and the other for storing used toilet paper after anal cleaning with a small stick to compress it in the container (you can throw toilet paper in the excreta hole but it may retard the drying process of the faeces by covering them).
- After each use (of defecation), sprinkle two bowls or shovelfuls of dry absorbents over the faeces and return the cover attached to the pan. Their application absorbs moisture, increases pH, controls bad odours, prevents fly breeding and makes faeces less unsightly to the next user.
- Paper used for anal cleaning stored in a container should be burnt regularly outside the house.
- Keep a brush or small piece of cloth for cleaning the pan at regular intervals without pouring water in the excreta- hole.
- Wash hands with soap after defecation, handling urine container and cleaning the squatting pan. Always wear gloves while emptying the faeces vault and wash hands with soap afterwards.
- Always keep two small urine containers and two large urine containers. The large urine containers with tight lids should be placed in a shed for storing the urine from the small containers. Two small containers (with a small inlet for inserting urine pipe) should be used alternately to collect urine. Urine containers should be closed at all times to prevent odour and loss of ammonia into the air. When the first large urine container is full seal it properly for at least 30 days before using as a liquid fertiliser.
- In kitchen gardens, urine may be applied directly but the time gap between urine applications and harvesting should be in any case one month. Urine contains salt so plain watering would be beneficial after urine application for better plant growth.
- Apply undiluted urine to open soil. For plants in growth urine can be used diluted or undiluted. If urine is diluted then use one part urine with three parts of water. For crops with smaller roots apply urine in smaller doses. For fertilising nearly 670 m2 of land, approximately 850 litres of urine would be required i.e. roughly the total urine discharge of two adults in a year.
- The first vault can be used for at least 6 months, depending on the vault’s volume. When it is full the vault is sealed. All openings are tightly closed, e.g. with lime mortar or clay. The other vault now comes into use instead. When the second vault is nearly full, the first vault has to be emptied.
- The dehydrated faeces, now odourless, can be reused as a soil conditioner. Further storage or co-composting with other organic materials is recommended to increase hygienic safety.
- The use of the compost should be planned in advance (400 - 500 kg humus per family per year can be formed).
- Wash the urine pipe at regular intervals by passing small quantities of water through it from the squatting pan, where it is attached.

Appendix 2

Bill of quantities for 2 single vault UDDTs and 2 Bathrooms

Project **COST ESTIMATE FOR A PROPOSED 2 UNIT SINGLE VAULT UDDT AND 2 BATHROOMS BLOCK**

Designed by: Edward Muchiri, - ROSA / Civil Engineering, Egerton University

Date: **20th September 2009**

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
A	**EXCAVATION AND EARTHWORKS**				
1	Excavate to remove top vegetative soil average 200mm deep and hauling from site	sm	6.5	40	258.72
	sub-total to be carried to collection				**258.72**
B	**WALLING FOR FOUNDATION AND VAULTS**				
1	Undressed Natural stones	Lm	69.7	65.6	4573.63
2	Cement	Bag	3.0	800	2405.06
3	Sand	Tons	0.5	750	405.35
4	Stairs -Cement	Bag	1.0	800	800.00
	-sand	Sand	0.5	750	375.00
5	Labour (1 Masons)	man days	1.0	500	500.00
6	Labour (assistants)	M/day	2.0	250	500.00
	sub-total to be carried to collection				**9559.05**
C	**CONCRETING**				
	Reinforced conc. (1:2:4) for suspended floor slab 150mm				
1	Cement	Bags	4.0	800	3200.00
2	Sand	ton	1.0	700	700.00
3	Aggregate	ton	2.0	750	1500.00
4	Steel works: Y10 @200c/c	no	2.0	600	1200.00
5	Binding wire	kg	1.0	160	160.00
F	200mm x 25mm timber Shuttering (off cuts)	Lm	98.9	30	2967.00
G	150mm x 25mm formwork	LM	20.0	75	1500.00
6	Labour (1 mason)	man-day	1.0	500	500.00
7	Labour (assistants)	man-day	2.0	250	500.00
	Sub total to be carried to grand summary				**12227.00**
D	**WALLING FOR SUPERSTRUCTURE**				
1	Natural stone walling to superstructure (150mm)	LM	112.0	65.5	7336.00
2	Cement	Bags	5.6	800	4443.08
3	Sand	ton	0.8	750	624.04
4	Stone dressing	LM	70.0	15	1050.00
5	Labour (1 mason)	man-day	3.0	500	1500.00
6	Labour (2 assistants)	man-day	3.0	250	750.00
	sub total to be carried to grand summary				**15703.12**
E	**ROOFING and RAINWATER HARVESTING**				
1	100X50 mm wall plate	Lm	10.0	75	750.00
2	75x50mm purlin	LM	13.5	66	891.00

3	200x25mm fascia board	LM	13.5	131	1768.50
4	30gx2.0m GCI roof sheet	no.	6.0	600	3600.00
5	Ridge cap gauge 30	LM	3.0	120	360.00
6	Roofing Nails	kg	1.0	230	230.00
7	28G x 200mm Gutters with gutter holder	no.	3.0	200	600.00
8	Nails 100mm	kg	1.0	150	150.00
9	Nails 50mm	kg	0.5	150	75.00
10	Plastic tank 200 Litre for rainwater collection	no.	1.0	1000	1000.00
11	hand washing basins with 2 taps and fittings	no.	1.0	1000	1000.00
12	Labour- Artisans	M/day	2.0	500	1000.00
13	Labour- casual assistants		2.0	250	500.00
	sub total to be carried to grand summary				**11924.50**
F	**DOORS & PLUMBING**				
1	1950X800 mm T&G cyprus timber door fixed	no	4.0	1500	6000.00
2	100x50mm cyprus frame with braces, middle rail with top light vent	no	4.0	1000	4000.00
3	Mesh net for vent	sm	1.5	100	150.00
4	Butt hinges 100mm	no.	8.0	40	320.00
5	Door latch 100mm	no.	4.0	100	400.00
6	Nails 50mm	kg	1.0	150	150.00
7	Labour Carpenter	M/day	2.0	500	1000.00
8	eko plate pedestal	no.	2.0	1200	2400.00
9	Steel vault doors 900 x 700	no	2.0	2500	5000.00
10	32mm dia. Upvc drain pipe	no	1.0	200	200.00
11	32mm tee	no	2.0	50	100.00
12	32mm bend	no	2.0	60	120.00
13	Buckets 50 Ltrs	no	4.0	350	1400.00
	sub total to be carried to grand summary				**21240.00**
G	**FINISHES, PLASTER AND PAINTING**				
1	15mm thick two coat1:4 Cement/Mortar plaster trowelled smooth and comprising 12mm backing and 3mm c/screed finishing coat	sm	29.9		
2	Cement	bags	9.3	800	7432.13
3	Sand	ton	2.0	750	1463.20
4	3mm screed cement	bags	4.1	800	3303.17
5	Rendering 15mm to external wall and pointing to external wall	bags	1.0	800	800.00 0.00
6	prepare and apply one u/coat, 2 finishing coats vesta oil paint to plasted walls	litres	9.0	200	0.00 1795.20
7	ditto to wooden surfaces	litres	5.8	200	1152.00
8	Labour plastering	man-day	4.0	500	2000.00
9	Labour plastering-assistant	man-day	4.0	250	1000.00
10	Labour painting	man-day	2.0	500	1000.00
	sub total to be carried to grand summary				**19945.70**

GRAND SUMMARY

ELEMENT	DESCRIPTION		AMOUNT
A	EXCAVATION AND EARTH WORKS		258.00
B	WALLING FOR PIT LINING		9559.05
C	CONCRETING FOR REINFORCED SUSPENDED FLOOR SLAB		12227.00
D	WALLING FOR SUPERSTRUCTURE		15703.12
E	ROOFING		11324.50
F	DOORS and PLUMBING		21240.00
G	FINISHES, PLASTER AND PAINTING		19945.70
	Total		**90257.36**
	CONTINGENCIES	20%	18051.47
	GRAND TOTAL	**KSHS**	**108308.83**

Appendix 3

Pictures of the estates Hilton and London in Nakuru, Kenya

All pictures are taken in November 2009.

Building structures

Streets

View to the neighbouring area and the dump site

Appendix 4
Number of container-emptyings per month, year one to five

Number of container-emptyings per month, year one to five

year 1 (24 UDDTs)

customer	No. Of UDDT	No. of container	Fill up time (days)	No. of container-emptyings per month per customer											
				Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	5	15	45	5	5		5	5		5	5		5	5	
2	2	6	60		2		2		2		2		2		2
3	2	6	180	1						1					
4	3	9	60	3		3		3		3		3		3	
5	4	12	60		4		4		4		4		4		4
6	2	6	60	2		2		2		2		2		2	
7	2	6	60			2		2		2		2		2	
8	2	6	120			2				2				2	
9	2	6	60			2		2		2		2		2	
10 (assumed)	2	6	60												
11 (assumed)	2	6	60												
12 (assumed)	2	6	60												
Total no. of container-emptyings per month				**11**	**11**	**11**	**11**	**14**	**6**	**17**	**11**	**9**	**11**	**16**	**6**

Number of container-emptyings per month, year one to five

	year 2 (24 UDDTs)													year 3 (28 UDDTs)											
	No. of container-emptyings per month per customer													**No. of container-emptyings per month per customer**											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	5	5		5	5		5	5		5	5			5	5		5	5		5	5		5	5	
		2		2		2		2		2		2			2		2		2		2		2		2
	1						1							1						1					
	3		3		3		3		3		3			3		3		3		3		3		3	
		4		4		4		4		4		4			4		4		4		4		4		4
	2		2		2		2		2		2			2		2		2		2		2		2	
	2		2		2		2		2		2			2		2		2		2		2		2	
		2				2				2					2				2				2		
	2		2		2		2		2		2			2		2		2		2		2		2	
															2		2		2		2		2		2
															2		2		2		2		2		2
Total no. of container-emptyings per month	**15**	**13**	**9**	**11**	**14**	**8**	**15**	**11**	**9**	**13**	**14**	**6**		**15**	**17**	**9**	**15**	**14**	**12**	**15**	**15**	**9**	**17**	**14**	**10**

Number of container-emptyings per month, year one to five

	year 4 (30 UDDTs)												year 5 (30 UDDTs)											
	No. of container-emptyings per month per customer												**No. of container-emptyings per month per customer**											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	5	5		5	5		5	5		5	5		5	5		5	5		5	5		5	5	
		2		2		2		2		2		2		2		2		2		2		2		2
	1						1						1						1					
	3		3		3		3		3		3		3		3		3		3		3		3	
		4		4		4		4		4		4		4		4		4		4		4		4
	2		2		2		2		2		2		2		2		2		2		2		2	
	2		2		2		2		2		2		2		2		2		2		2		2	
		2				2				2				2				2				2		
	2		2		2		2		2		2		2		2		2		2		2		2	
		2		2		2		2		2		2		2		2		2		2		2		2
		2		2		2		2		2		2		2		2		2		2		2		2
	2		2		2		2		2		2		2		2		2		2		2		2	
Total no. of container-emptyings per month	**17**	**17**	**11**	**15**	**16**	**12**	**17**	**15**	**11**	**17**	**16**	**10**	**17**	**17**	**11**	**15**	**16**	**12**	**17**	**15**	**11**	**17**	**16**	**10**

Appendix 5
Monthly Income Statement year one to five

MEWAREMA projected income Statement	Year 1	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenues (service-branch)	**18'800**	1'700	1'500	1'500	1'700	1'800	1'000	2'300	1'500	1'300	1'700	2'000	800
Costs													
wages	28'800	2'400	2'400	2'400	2'400	3'000	1'800	3'000	2'400	1'800	2'400	3'000	1'800
depreciation (collection cart, equipment)													
other costs (donkey food, water, maintenance)	4290	357.5	357.5	357.5	357.5	367.5	347.5	367.5	357.5	347.5	357.5	367.5	347.5
Operating Profit (service-branch)	**-14'290**	-1'058	-1'258	-1'258	-1'058	-1'568	-1'148	-1'068	-1'258	-848	-1'058	-1'368	-1'348
Revenues (manufacturing-branch)	**48300**	0	0	0	0	5775	5775	5775	5775	7350	3150	8925	5775
Cost of goods sold													
Opening finished goods 01.01. 2011													
Cost of goods manufactured (see panel D)	62400	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200
Cost of goods available for sale													
closing finished goods 31.12.2011													
Gross margin	-14100	-5200	-5200	-5200	-5200	575	575	575	575	2150	-2050	3725	575
Operating costs:													
marketing (advertising per UDDT 10kg compost =	1200												
general and administrative (supervisor salary)	2400												
Operating profit (manufacturing-branch)	**-17700**	-5200	-5200	-5200	-5200	575	575	575	575	2150	-2050	3725	575
Overall Profit (loss)	**-31'990**	-6'258	-6'458	-6'458	-6'258	-993	-573	-493	-683	1'303	-3'108	2'358	-773

MEWAREMA projected income Statement	Year 2	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenues (service-branch)	**19'200**	2'100	1'700	1'300	1'700	1'800	1'200	2'100	1'500	1'300	1'900	1'800	800
Costs													
wages	28'800	3'000	2'400	1'800	2'400	3'000	1'800	3'000	2'400	1'800	2'400	3'000	1'800
depreciation (collection cart, equipment)													
other costs (donkey food, water, maintenance)	4290	367.5	357.5	347.5	357.5	367.5	347.5	367.5	357.5	347.5	357.5	367.5	347.5
Operating Profit (service-branch)	**-13'890**	-1'268	-1'058	-848	-1'058	-1'568	-948	-1'268	-1'258	-848	-858	-1'568	-1'348
Revenues (manufacturing-branch)	**72450**	4725	5775	8400	3150	7875	6825	4725	5775	7350	4200	7875	5775
Cost of goods sold													
Opening finished goods 01.01. 2012													
Cost of goods manufactured (see panel D)	62400	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200
Cost of goods available for sale													
closing finished goods 31.12.2012													
Gross margin	10050	-475	575	3200	-2050	2675	1625	-475	575	2150	-1000	2675	575
Operating costs:													
marketing (advertising per UDDT 10kg compost =	1200												
general and administrative (supervisor salary)	2400												
Operating profit (manufacturing-branch)	**6450**	-475	575	3200	-2050	2675	1625	-475	575	2150	-1000	2675	575
Overall Profit (loss)	**-7'440**	-1'743	-483	2'353	-3'108	1'108	678	-1'743	-683	1'303	-1'858	1'108	-773

MEWAREMA projected income Statement	Year 3	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenues (service-branch)	**21'600**	2'100	2'100	1'300	2'100	1'800	1'600	2'100	1'900	1'300	2'300	1'800	1'200
Costs													
wages	32'400	3'000	3'000	1'800	3'000	3'000	2'400	3'000	3'000	1'800	3'000	3'000	2'400
depreciation (collection cart, equipment)													
other costs (donkey food, water, maintenance)	4350	367.5	367.5	347.5	367.5	367.5	357.5	367.5	367.5	347.5	367.5	367.5	357.5
Operating Profit (service-branch)	**-15'150**	-1'268	-1'268	-848	-1'268	-1'568	-1'158	-1'268	-1'468	-848	-1'068	-1'568	-1'558
Revenues (manufacturing-branch)	**80850**	4725	6825	7350	3150	7875	8925	4725	7875	7350	6300	7875	7875
Cost of goods sold													
Opening finished goods 01.01. 2013													
Cost of goods manufactured (see panel D)	62400	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200
Cost of goods available for sale													
closing finished goods 31.12.2013													
Gross margin	18450	-475	1625	2150	-2050	2675	3725	-475	2675	2150	1100	2675	2675
Operating costs:													
marketing (advertising per UDDT 10kg compost =	1400												
general and administrative (supervisor salary)	2400												
Operating profit (manufacturing-branch)	**14650**	-475	1625	2150	-2050	2675	3725	-475	2675	2150	1100	2675	2675
Overall Profit (loss)	**-500**	-1'743	358	1'303	-3'318	1'108	2'568	-1'743	1'208	1'303	33	1'108	1'118

MEWAREMA projected income Statement	Year 4	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenues (service-branch)	**22'800**	2'300	2'100	1'500	2'100	2'000	1'600	2'300	1'900	1'500	2'300	2'000	1'200
Costs													
wages	33'600	3'000	3'000	2'400	3'000	3'000	2'400	3'000	3'000	2'400	3'000	3'000	2'400
depreciation (collection cart, equipment)													
other costs (donkey food, water, maintenance)	4370	367.5	367.5	357.5	367.5	367.5	357.5	367.5	367.5	357.5	367.5	367.5	357.5
Operating Profit (service-branch)	**-15'170**	-1'068	-1'268	-1'258	-1'268	-1'368	-1'158	-1'068	-1'468	-1'258	-1'068	-1'368	-1'558
Revenues (manufacturing-branch)	**89250**	4725	8925	7350	5250	8925	8925	5775	7875	8400	6300	8925	7875
Cost of goods sold													
Opening finished goods 01.01. 2014													
Cost of goods manufactured (see panel D)	62400	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200
Cost of goods available for sale													
closing finished goods 31.12.2014													
Gross margin	26850	-475	3725	2150	50	3725	3725	575	2675	3200	1100	3725	2675
Operating costs:													
marketing (advertising per UDDT 10kg compost =	1500												
general and administrative (supervisor salary)	2400												
Operating profit (manufacturing-branch)	**22950**	-475	3725	2150	50	3725	3725	575	2675	3200	1100	3725	2675
Overall Profit (loss)	**7'780**	-1'543	2'458	893	-1'218	2'358	2'568	-493	1'208	1'943	33	2'358	1'118

MEWAREMA projected income Statement	Year 5	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenues (service-branch)	**22'800**	2'300	2'100	1'500	2'100	2'000	1'600	2'300	1'900	1'500	2'300	2'000	1'200
Costs													
wages	33'600	3'000	3'000	2'400	3'000	3'000	2'400	3'000	3'000	2'400	3'000	3'000	2'400
depreciation (collection cart, equipment)													
other costs (donkey food, water, maintenance)	4370	367.5	367.5	357.5	367.5	367.5	357.5	367.5	367.5	357.5	367.5	367.5	357.5
Operating Profit (service-branch)	**-15'170**	-1'068	-1'268	-1'258	-1'268	-1'368	-1'158	-1'068	-1'468	-1'258	-1'068	-1'368	-1'558
Revenues (manufacturing-branch)	**91350**	5775	8925	8400	5250	8925	8925	5775	7875	8400	6300	8925	7875
Cost of goods sold													
Opening finished goods 01.01. 2015													
Cost of goods manufactured (see panel D)	62400	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200
Cost of goods available for sale													
closing finished goods 31.12.2015													
Gross margin	28950	575	3725	3200	50	3725	3725	575	2675	3200	1100	3725	2675
Operating costs:													
marketing (advertising per UDDT 10kg compost =	1500												
general and administrative (supervisor salary)	2400												
Operating profit (manufacturing-branch)	**25050**	575	3725	3200	50	3725	3725	575	2675	3200	1100	3725	2675
Overall Profit (loss)	**13'780**	-493	2'458	1'943	-1'218	2'358	2'568	-493	1'208	1'943	33	2'358	1'118

Appendix 6

Calculation of Collection and Transport Costs, year one to five

COLLECTION AND TRANSPORT

	Year 1	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
faecal matter container emptied	134	11	11	11	11	14	6	17	11	9	11	16	6
Revenues (Ksh) faecal matter	13'400	1'100	1'100	1'100	1'100	1'400	600	1'700	1'100	900	1'100	1'600	600
urine container emptied	54	6	4	4	6	4	4	6	4	4	6	4	2
Revenues (Ksh) urine	5'400	600	400	400	600	400	400	600	400	400	600	400	200
Revenues (Ksh) (urine and faecal matter)	18'800	1'700	1'500	1'500	1'700	1'800	1'000	2'300	1'500	1'300	1'700	2'000	800
Amount of faecal matter (kg)	6'700	550	550	550	550	700	300	850	550	450	550	800	300
capacity of cart: 300kg -> min. days required for transport		1.83	1.83	1.83	1.83	2.33	1.00	2.83	1.83	1.50	1.83	2.67	1.00
max. working days = min. days *1.5 faecal matter coll.		2.75	2.75	2.75	2.75	3.50	1.50	4.25	2.75	2.25	2.75	4.00	1.50
Amount of urine (l)	2'700	300	200	200	300	200	200	300	200	200	300	200	100
capacity of cart: 300kg -> min. days required for transport		1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.33
maximal Working days urine collection	12.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
maximal Working days faecal matter and urine collection		3.75	3.75	3.75	3.75	4.50	2.50	5.25	3.75	3.25	3.75	5.00	2.50
maximal Working days faecal matter an durine collection (rounded)	48.00	4.00	4.00	4.00	4.00	5.00	3.00	5.00	4.00	3.00	4.00	5.00	3.00
wages operators collection and transport (2 x 300 Ksh/ day)	28'800	2'400	2'400	2'400	2'400	3'000	1'800	3'000	2'400	1'800	2'400	3'000	1'800

For the Numberof container emptied see Appendix 4 "Number of container-emptyings per month, year one to five".

COLLECTION AND TRANSPORT

	Year 2	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
faecal matter container emptied	138	15	13	9	11	14	8	15	11	9	13	14	6
Revenues (Ksh) faecal matter	13'800	1'500	1'300	900	1'100	1'400	800	1'500	1'100	900	1'300	1'400	600
urine container emptied	54	6	4	4	6	4	4	6	4	4	6	4	2
Revenues (Ksh) urine	5'400	600	400	400	600	400	400	600	400	400	600	400	200
Revenues (Ksh) (urine and faecal matter)	19'200	2'100	1'700	1'300	1'700	1'800	1'200	2'100	1'500	1'300	1'900	1'800	800
Amount of faecal matter (kg)	6'900	750	650	450	550	700	400	750	550	450	650	700	300
capacity of cart: 300kg -> min. days required for transport	23	2.50	2.17	1.50	1.83	2.33	1.33	2.50	1.83	1.50	2.17	2.33	1.00
max. working days = min. days *1.5 faecal matter coll.	34.50	3.75	3.25	2.25	2.75	3.50	2.00	3.75	2.75	2.25	3.25	3.50	1.50
Amount of urine (l)	2'700	300	200	200	300	200	200	300	200	200	300	200	100
capacity of cart: 300kg -> min. days required for transport	9	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.33
maximal Working days urine collection		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
maximal Working days faecal matter and urine collection	34.50	4.75	4.25	3.25	3.75	4.50	3.00	4.75	3.75	3.25	4.25	4.50	2.50
maximal Working days faecal matter an durine collection (rounded)	48.00	5.00	4.00	3.00	4.00	5.00	3.00	5.00	4.00	3.00	4.00	5.00	3.00
wages operators collection and transport (2 x 300 Ksh/ day)	28'800	3'000	2'400	1'800	2'400	3'000	1'800	3'000	2'400	1'800	2'400	3'000	1'800

COLLECTION AND TRANSPORT

	Year 3	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
faecal matter container emptied	162	15	17	9	15	14	12	15	15	9	17	14	10
Revenues (Ksh) faecal matter	16'200	1'500	1'700	900	1'500	1'400	1'200	1'500	1'500	900	1'700	1'400	1'000
urine container emptied	54	6	4	4	6	4	4	6	4	4	6	4	2
Revenues (Ksh) urine	5400	600	400	400	600	400	400	600	400	400	600	400	200
Revenues (Ksh) (urine and faecal matter)	21'600	2'100	2'100	1'300	2'100	1'800	1'600	2'100	1'900	1'300	2'300	1'800	1'200
Amount of faecal matter (kg)	8100	750	850	450	750	700	600	750	750	450	850	700	500
capacity of cart: 300kg -> min. days required for transport	27	2.50	2.83	1.50	2.50	2.33	2.00	2.50	2.50	1.50	2.83	2.33	1.67
max. working days = min. days *1.5 faecal matter coll.	40.50	3.75	4.25	2.25	3.75	3.50	3.00	3.75	3.75	2.25	4.25	3.50	2.50
Amount of urine (l)	2700	300	200	200	300	200	200	300	200	200	300	200	100
capacity of cart: 300kg -> min. days required for transport	9	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.33
maximal Working days urine collection		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
maximal Working days faecal matter and urine collection	40.50	4.75	5.25	3.25	4.75	4.50	4.00	4.75	4.75	3.25	5.25	4.50	3.50
maximal Working days faecal matter an durine collection (rounded)	54.00	5.00	5.00	3.00	5.00	5.00	4.00	5.00	5.00	3.00	5.00	5.00	4.00
wages operators collection and transport (2 x 300 Ksh/ day)	32'400	3'000	3'000	1'800	3'000	3'000	2'400	3'000	3'000	1'800	3'000	3'000	2'400

COLLECTION AND TRANSPORT

	Year 4	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
faecal matter container emptied	174	17	17	11	15	16	12	17	15	11	17	16	10
Revenues (Ksh) faecal matter	17'400	1'700	1'700	1'100	1'500	1'600	1'200	1'700	1'500	1'100	1'700	1'600	1'000
urine container emptied	54	6	4	4	6	4	4	6	4	4	6	4	2
Revenues (Ksh) urine	5400	600	400	400	600	400	400	600	400	400	600	400	200
Revenues (Ksh) (urine and faecal matter)	22'800	2'300	2'100	1'500	2'100	2'000	1'600	2'300	1'900	1'500	2'300	2'000	1'200
Amount of faecal matter (kg)	8700	850	850	550	750	800	600	850	750	550	850	800	500
capacity of cart: 300kg -> min. days required for transport	29	2.83	2.83	1.83	2.50	2.67	2.00	2.83	2.50	1.83	2.83	2.67	1.67
max. working days = min. days *1.5 faecal matter coll.	43.50	4.25	4.25	2.75	3.75	4.00	3.00	4.25	3.75	2.75	4.25	4.00	2.50
Amount of urine (l)	2700	300	200	200	300	200	200	300	200	200	300	200	100
capacity of cart: 300kg -> min. days required for transport	9	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.33
maximal Working days urine collection		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
maximal Working days faecal matter and urine collection	43.50	5.25	5.25	3.75	4.75	5.00	4.00	5.25	4.75	3.75	5.25	5.00	3.50
maximal Working days faecal matter an durine collection (rounded)	56.00	5.00	5.00	4.00	5.00	5.00	4.00	5.00	5.00	4.00	5.00	5.00	4.00
wages operators collection and transport (2 x 300 Ksh/ day)	33'600	3'000	3'000	2'400	3'000	3'000	2'400	3'000	3'000	2'400	3'000	3'000	2'400

COLLECTION AND TRANSPORT

	Year 5	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
faecal matter container emptied	174	17	17	11	15	16	12	17	15	11	17	16	10
Revenues (Ksh) faecal matter	17'400	1'700	1'700	1'100	1'500	1'600	1'200	1'700	1'500	1'100	1'700	1'600	1'000
urine container emptied	54	6	4	4	6	4	4	6	4	4	6	4	2
Revenues (Ksh) urine	5400	600	400	400	600	400	400	600	400	400	600	400	200
Revenues (Ksh) (urine and faecal matter)	22'800	2'300	2'100	1'500	2'100	2'000	1'600	2'300	1'900	1'500	2'300	2'000	1'200
Amount of faecal matter (kg)	8700	850	850	550	750	800	600	850	750	550	850	800	500
capacity of cart: 300kg -> min. days required for transport	29	2.83	2.83	1.83	2.50	2.67	2.00	2.83	2.50	1.83	2.83	2.67	1.67
max. working days = min. days *1.5 faecal matter coll.	43.50	4.25	4.25	2.75	3.75	4.00	3.00	4.25	3.75	2.75	4.25	4.00	2.50
Amount of urine (l)	2700	300	200	200	300	200	200	300	200	200	300	200	100
capacity of cart: 300kg -> min. days required for transport	9	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.33
maximal Working days urine collection		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
maximal Working days faecal matter and urine collection	43.50	5.25	5.25	3.75	4.75	5.00	4.00	5.25	4.75	3.75	5.25	5.00	3.50
maximal Working days faecal matter an durine collection (rounded)	56.00	5.00	5.00	4.00	5.00	5.00	4.00	5.00	5.00	4.00	5.00	5.00	4.00
wages operators collection and transport (2 x 300 Ksh/ day)	33'600	3'000	3'000	2'400	3'000	3'000	2'400	3'000	3'000	2'400	3'000	3'000	2'400

Appendix 7

Calculation of Treatment (manufacturing of compost) Costs, year one to five

TREATMENT, MANUFACTURING OF COMPOST

	Year 1	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenu (sales) (Ksh)	48300					**5775**	**5775**	**5775**	**5775**	**7350**	**3150**	**8925**	**5775**
Amount of faecal matter (kg)	6700	550	550	550	550	700	300	850	550	450	550	800	300
organic waste 2:1 faecal matter													
amount of compost to be treated	20100	1650	1650	1650	1650	2100	900	2550	1650	1350	1650	2400	900
amount ready to sale	**9660**					**1155**	**1155**	**1155**	**1155**	**1470**	**630**	**1785**	**1155**
sold (100%)													
one person can manually produce 200 kg of compost a day	100.5	8.25	8.25	8.25	8.25	10.5	4.5	12.8	8.25	6.75	8.25	12	4.5
No. of treatment operators		2	2	2	2	2	2	2	2	2	2	2	2
working days of operators	50.25	4.125	4.125	4.125	4.125	5.25	2.25	6.38	4.125	3.375	4.125	6	2.25
maximal working days of transport operators	47	4	4	4	4	5	3	5	4	3	4	5	3
maintenace (plus 1 day)	0	0	0	0	0	0	0	0	0	0	0	0	0
total working days of operators	96	8	8	8	8	8	8	8	8	8	8	8	8
wages operators co-composting (2 x 300 Ksh/ day)	57'600	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800

The composting system is explained in chapter 5.2.2 busines plan, V.2. Treatment and re-use

TREATMENT, MANUFACTURING OF COMPOST

	Year 2	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenu (sales) (Ksh)	72450	**4725**	**5775**	**8400**	**3150**	**7875**	**6825**	**4725**	**5775**	**7350**	**4200**	**7875**	**5775**
Amount of faecal matter (kg)	6'900	750	650	450	550	700	400	750	550	450	650	700	300
organic waste 2:1 faecal matter													
amount of compost to be treated	20700	2250	1950	1350	1650	2100	1200	2250	1650	1350	1950	2100	900
amount ready to sale	**14490**	**945**	**1155**	**1680**	**630**	**1575**	**1365**	**945**	**1155**	**1470**	**840**	**1575**	**1155**
sold (100%)													
one person can manually produce 200 kg of compost a day	103.5	11.25	9.75	6.75	8.25	10.5	6	11.25	8.25	6.75	9.75	10.5	4.5
No. of treatment operators	24	2	2	2	2	2	2	2	2	2	2	2	2
working days of operators	51.75	5.625	4.88	3.375	4.13	5.25	3	5.625	4.13	3.375	4.88	5.25	2.25
maximal working days of transport operators	48	5	4	3	4	5	3	5	4	3	4	5	3
maintenace (plus 1 day)	0	0	0	0	0	0	0	0	0	0	0	0	0
total working days of operators	96	8	8	8	8	8	8	8	8	8	8	8	8
wages operators co-composting (2 x 300 Ksh/ day)	57600	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800

TREATMENT, MANUFACTURING OF COMPOST

	Year 3	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenu (sales) (Ksh)	**80850**	**4725**	**6825**	**7350**	**3150**	**7875**	**8925**	**4725**	**7875**	**7350**	**6300**	**7875**	**7875**
Amount of faecal matter (kg)	8'100	750	850	450	750	700	600	750	750	450	850	700	500
organic waste 2:1 faecal matter													
amount of compost to be treated	24300	2250	2550	1350	2250	2100	1800	2250	2250	1350	2550	2100	1500
amount ready to sale	**16170**	**945**	**1365**	**1470**	**630**	**1575**	**1785**	**945**	**1575**	**1470**	**1260**	**1575**	**1575**
sold (100%)													
one person can manually produce 200 kg of compost a day	**121.5**	11.25	12.8	6.75	11.3	10.5	9	11.25	11.3	6.75	12.8	10.5	7.5
No. of treatment operators	**24**	2	2	2	2	2	2	2	2	2	2	2	2
working days of operators	**60.75**	5.625	6.38	3.375	5.63	5.25	4.5	5.625	5.63	3.375	6.38	5.25	3.75
maximal working days of transport operators	**54**	5	5	3	5	5	4	5	5	3	5	5	4
maintenace (plus 1 day)	0	0	0	0	0	0	0	0	0	0	0	0	0
total working days of operators	**96**	8	8	8	8	8	8	8	8	8	8	8	8
wages operators co-composting (2 x 300 Ksh/ day)	**57600**	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800

TREATMENT, MANUFACTURING OF COMPOST

	Year 4	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenu (sales) (Ksh)	**89250**	**4725**	**8925**	**7350**	**5250**	**8925**	**8925**	**5775**	**7875**	**8400**	**6300**	**8925**	**7875**
Amount of faecal matter (kg)	8'700	850	850	550	750	800	600	850	750	550	850	800	500
organic waste 2:1 faecal matter													
amount of compost to be treated	26100	2550	2550	1650	2250	2400	1800	2550	2250	1650	2550	2400	1500
amount ready to sale	**17850**	**945**	**1785**	**1470**	**1050**	**1785**	**1785**	**1155**	**1575**	**1680**	**1260**	**1785**	**1575**
sold (100%)													
one person can manually produce 200 kg of compost a day	**130.5**	12.75	12.75	8.25	11.25	12	9	12.75	11.25	8.25	12.75	12	7.5
No. of treatment operators	**24**	2	2	2	2	2	2	2	2	2	2	2	2
working days of operators	**65.25**	6.375	6.375	4.125	5.625	6	4.5	6.375	5.625	4.125	6.375	6	3.75
maximal working days of transport operators	**56**	5	5	4	5	5	4	5	5	4	5	5	4
maintenace (plus 1 day)	0	0	0	0	0	0	0	0	0	0	0	0	0
total working days of operators	**96**	8	8	8	8	8	8	8	8	8	8	8	8
wages operators co-composting (2 x 300 Ksh/ day)	**57600**	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800

TREATMENT, MANUFACTURING OF COMPOST

	Year 5	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Revenu (sales) (Ksh)	**91350**	**5775**	**8925**	**8400**	**5250**	**8925**	**8925**	**5775**	**7875**	**8400**	**6300**	**8925**	**7875**
Amount of faecal matter (kg)	8'700	850	850	550	750	800	600	850	750	550	850	800	500
organic waste 2:1 faecal matter	**0**												
amount of compost to be treated	26100	2550	2550	1650	2250	2400	1800	2550	2250	1650	2550	2400	1500
amount ready to sale	**18270**	**1155**	**1785**	**1680**	**1050**	**1785**	**1785**	**1155**	**1575**	**1680**	**1260**	**1785**	**1575**
sold (100%)	**0**												
one person can manually produce 200 kg of compost a day	**130.5**	12.75	12.75	8.25	11.25	12	9	12.75	11.25	8.25	12.75	12	7.5
No. of treatment operators	**24**	2	2	2	2	2	2	2	2	2	2	2	2
working days of operators	**65.25**	6.375	6.375	4.125	5.625	6	4.5	6.375	5.625	4.125	6.375	6	3.75
maximal working days of transport operators	**56**	5	5	4	5	5	4	5	5	4	5	5	4
maintenace (plus 1 day)	0	0	0	0	0	0	0	0	0	0	0	0	0
total working days of operators	**96**	8	8	8	8	8	8	8	8	8	8	8	8
wages operators co-composting (2 x 300 Ksh/ day)	**57600**	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800

Appendix 8

Fix and Variable Costs for the Breakeven Point Analysis, year one to five

Fix and Variable Costs

			Year 1	
	Unit			Revenues (KES)
SERVICE-BRANCHE				
Number of UDDTs	unit		24	
container emptied	unit		134	18800
maximal Working days	days/year		48	
wages (600 KES per day)	KES		28800	
wages minus service revenue	KES		10'000	
other costs:	KES		4290	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		480	
Cost of food for donkeys per donkey cart	KES/month	20	20	
	KES/year	240	240	
Maintenence cost of donkey cart (7% of investment cost)	KES/year	3570	3570	
cleaning material	KES/month			
	KES/year		0	
MANUFACTURING-BRANCHE				
Amount of faecal matter collected	kg/year		6700	
amount of compost to be treated	kg compost/ year		20100	
amount ready for sale	kg		9660	48300
maximal working days	day		96	
wages (600 KES per day)	KES		57600	
other costs:	KES		*4792*	
Supplies (organic waste)	KES		0	
Depreciation - plant equipment	KES		0	
samling	KES		0	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		960	
Maintenance cost of co-composting plant (5% of investment cost)	KES/year	3832	3832	
Miscellaneous	KES	0	0	
OPERATING COSTS				
marketing (advertising per UDDT 10kg compost = 50 KES)	KES/year		1200	
general and administrative	KES/year	2400	2400	
operating fix costs	KES		67642	
operating variable costs	KES		12'640	
revenues	KES			67'100
overall profit (loss)	KES		-30'782	
unit varibale cost	KES		1.31	
variable cost as a percentage of sales	%		0.26	
fix + variable costs	KES		80282.00	
costs per unit	KES		8.31	
selling price per unit	KES		5.00	
operating fix costs	KES		67642.00	
unit varibale cost	KES		1.31	
Break even output	Kg		18323.66	
Break even sales	KES		91618.30	

Fix and Variable Costs

			Year 2	
	Unit			Revenues (KES)
SERVICE-BRANCHE				
Number of UDDTs	unit		24	
container emptied	unit		138	19700
maximal Working days	days/year		48	
wages (600 KES per day)	KES		28800	
wages minus service revenue	KES		9'100	
other costs:	KES		4290	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		480	
Cost of food for donkeys per donkey cart	KES/month	20	20	
	KES/year	240	240	
Maintenence cost of donkey cart (7% of investment cost)	KES/year	3570	3570	
cleaning material	KES/month			
	KES/year		0	
MANUFACTURING-BRANCHE				
Amount of faecal matter collected	kg/year		6900	
amount of compost to be treated	kg compost/ year		20700	
amount ready for sale	kg		14490	72450
maximal working days	day		96	
wages (600 KES per day)	KES		57600	
other costs:	KES		*4792*	
Supplies (organic waste)	KES		0	
Depreciation - plant equipment	KES		0	
samling	KES		0	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		960	
Maintenance cost of co-composting plant (5% of investment cost)	KES/year	3832	3832	
Miscellaneous	KES	0	0	
OPERATING COSTS				
marketing (advertising per UDDT 10kg compost = 50 KES)	KES/year		1200	
general and administrative	KES/year	2400	2400	
operating fix costs	KES		67642	
operating variable costs	KES		11'740	
revenues	KES			92'150
overall profit (loss)	KES		-6'932	
unit varibale cost	KES		0.81	
variable cost as a percentage of sales	%		0.16	
fix + variable costs	KES		79382.00	
costs per unit	KES		5.48	
selling price per unit	KES		5.00	
operating fix costs	KES		67642.00	
unit varibale cost	KES		0.81	
Break even output	Kg		16144.50	
Break even sales	KES		80722.50	

Fix and Variable Costs

			Year 3	
	Unit			Revenues (KES)
SERVICE-BRANCHE				
Number of UDDTs	unit		28	
container emptied	unit		162	21600
maximal Working days	days/year		54	
wages (600 KES per day)	KES		32400	
wages minus service revenue	KES		10'800	
other costs:	KES		4290	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		540	
Cost of food for donkeys per donkey cart	KES/month	20	20	
	KES/year	240	240	
Maintenence cost of donkey cart (7% of investment cost)	KES/year	3570	3570	
cleaning material	KES/month			
	KES/year		0	
MANUFACTURING-BRANCHE				
Amount of faecal matter collected	kg/year		8100	
amount of compost to be treated	kg compost/ year		24300	
amount ready for sale	kg		16170	80850
maximal working days	day		96	
wages (600 KES per day)	KES		57600	
other costs:	KES		*4792*	
Supplies (organic waste)	KES		0	
Depreciation - plant equipment	KES		0	
samling	KES		0	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		960	
Maintenance cost of co-composting plant (5% of investment cost)	KES/year	3832	3832	
Miscellaneous	KES	0	0	
OPERATING COSTS				
marketing (advertising per UDDT 10kg compost = 50 KES)	KES/year		1400	
general and administrative	KES/year	2400	2400	
operating fix costs	KES		67642	
operating variable costs	KES		13'700	
revenues	KES			102'450
overall profit (loss)	KES		-492	
unit varibale cost	KES		0.85	
variable cost as a percentage of sales	%		0.17	
fix + variable costs	KES		81342.00	
costs per unit	KES		5.03	
selling price per unit	KES		5.00	
operating fix costs	KES		67642.00	
unit varibale cost	KES		0.85	
Break even output	Kg		16288.48	
Break even sales	KES		81442.38	

Fix and Variable Costs

			Year 4	
	Unit			Revenues (KES)
SERVICE-BRANCHE				
Number of UDDTs	unit		30	
container emptied	unit		174	22800
maximal Working days	days/year		56	
wages (600 KES per day)	KES		33600	
wages minus service revenue	KES		10'800	
other costs:	KES		4290	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		560	
Cost of food for donkeys per donkey cart	KES/month	20	20	
	KES/year	240	240	
Maintenence cost of donkey cart (7% of investment cost)	KES/year	3570	3570	
cleaning material	KES/month			
	KES/year		0	
MANUFACTURING-BRANCHE				
Amount of faecal matter collected	kg/year		8700	
amount of compost to be treated	kg compost/ year		26100	
amount ready for sale	kg		17850	89250
maximal working days	day		96	
wages (600 KES per day)	KES		57600	
other costs:	KES		*4792*	
Supplies (organic waste)	KES		0	
Depreciation - plant equipment	KES		0	
samling	KES		0	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		960	
Maintenance cost of co-composting plant (5% of investment cost)	KES/year	3832	3832	
Miscellaneous	KES	0	0	
OPERATING COSTS				
marketing (advertising per UDDT 10kg compost = 50 KES)	KES/year		1500	
general and administrative	KES/year	2400	2400	
operating fix costs	KES		67642	
operating variable costs	KES		13'820	
revenues	KES			112'050
overall profit (loss)	KES		7'788	
unit varibale cost	KES		0.77	
variable cost as a percentage of sales	%		0.15	
fix + variable costs	KES		81462.00	
costs per unit	KES		4.56	
selling price per unit	KES		5.00	
operating fix costs	KES		67642.00	
unit varibale cost	KES		0.77	
Break even output	Kg		16007.02	
Break even sales	KES		80035.11	

Fix and Variable Costs

			Year 5	
	Unit			Revenues (KES)
SERVICE-BRANCHE				
Number of UDDTs	unit		30	
container emptied	unit		174	22800
maximal Working days	days/year		56	
wages (600 KES per day)	KES		33600	
wages minus service revenue	KES		10'800	
other costs:	KES		4290	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		560	
Cost of food for donkeys per donkey cart	KES/month	20	20	
	KES/year	240	240	
Maintenence cost of donkey cart (7% of investment cost)	KES/year	3570	3570	
cleaning material	KES/month			
	KES/year		0	
MANUFACTURING-BRANCHE				
Amount of faecal matter collected	kg/year		8700	
amount of compost to be treated	kg compost/ year		26100	
amount ready for sale	kg		18270	91350
maximal working days	day		96	
wages (600 KES per day)	KES		57600	
other costs:	KES		*4792*	
Supplies (organic waste)	KES		0	
Depreciation - plant equipment	KES		0	
samling	KES		0	
water per working day	l/day	20		
	KES/day	10		
water	KES/year		960	
Maintenance cost of co-composting plant (5% of investment cost)	KES/year	3832	3832	
Miscellaneous	KES	0	0	
OPERATING COSTS				
marketing (advertising per UDDT 10kg compost = 50 KES)	KES/year		1500	
general and administrative	KES/year	2400	2400	
operating fix costs	KES		67642	
operating variable costs	KES		13'820	
revenues	KES			114'150
overall profit (loss)	KES		9'888	
unit varibale cost	KES		0.76	
variable cost as a percentage of sales	%		0.15	
fix + variable costs	KES		81462.00	
costs per unit	KES		4.46	
selling price per unit	KES		5.00	
operating fix costs	KES		67642.00	
unit varibale cost	KES		0.76	
Break even output	Kg		15939.89	
Break even sales	KES		79699.43	

Fix and Variable Costs year 1 to 5 including the Breakeven Points

Fix and Variable Costs	Unit	Year 1	Year 2	Year 3	Year 4	Year 5
operating fix costs	KES	67642	67642	67642	67642	67642
operating variable costs	KES	12640	11740	13700	13820	13820
fix + variable costs	KES	80282	79382	81342	81462	81462
revenues	KES	67100	92150	102450	112050	114150
overall profit (loss)	KES	-30782	-6932	-492	7788	9888
unit varibale cost	KES	1.31	0.81	0.85	0.77	0.76
variable cost as a percentage of sales	%	0.26	0.16	0.17	0.15	0.15
costs per unit	KES	8.31	5.48	5.03	4.56	4.46
Breakeven point						
selling price per unit	KES	5.00	5.00	5.00	5.00	5.00
operating fix costs	KES	67642	67642	67642	67642	67642
unit varibale cost	KES	1.31	0.81	0.85	0.77	0.76
Breakeven point in output	Kg	18323.66	16144.50	16288.48	16007.02	15939.89
Breakeven point in sales	KES	91618	80722	81442	80035	79699

Appendix 9

List of involved partners in the ROSA-Project

(taken from www.rosa.boku.ac.at)

University of Natural Resources and Applied Life Sciences Vienna (BOKU), Institute of Sanitary Engineering and Water Pollution Control, Austria
(Co-ordinator)

Hamburg University of Technology, Institute of Wastewater Management and Water Protection, Germany

EcoSan Club, Austria

London School of Hygiene and Tropical Medicine, Disease Control & Vector Biology Unit, Department of Infectious and Tropical Diseases, United Kingdom

WASTE, Advisors on Urban Environment and Development, The Netherlands

University of Dar es Salaam, Department of Water Resources Engineering, Tanzania

Makerere University, Department of Civil Engineering, Uganda

Egerton University, Department of Water and Environmental Engineering, Kenya

Arbaminch University, Research & Publication Coordination Department, Ethiopia

Kitgum Town Council, Uganda

Arusha City Council, Tanzania

Municipal Council of Nakuru Department of Environment, Kenya

Arba Minch Water Supply and Sewerage Enterprise, Ethiopia

Appendix 10
Telephone survey of UDDT owner

Content of the telephone survey of future or present UDDT owner

No. of UDDTs built or planned	No. of house-holds	No. of people living on the plot?	Garden or a small farm to use compost?		Willingness to use compost?	How much would you pay for collection service of feacal matter? [KSH]		How much would you pay for collection service of urin? [KSH]		How long does it take to fill the 50l container? [days]		How much you spend on water? [KSH/day]	How far is the plot from the co-composting site (dumpsite)? [m]
			garden	farm		per emptying 50 l	per month	per emptying 50 l	per month	feacal matter	urin		
5	28	112		x	yes	100	200	100	200	45	18	50	500
2	5	15	x	x	yes	75	150	100	400	60	30	450 per week	
2 [nursery and church]		20	x		yes	100	400	100	400	120	90	500 per month	
2		3	x		yes	50	200	urine is diverted to a soft pit				3000 per month	300
3 planned	9	30	x		yes								
4 planned		20	x		yes								
2 under construction			x		yes								
2 under construction		12	x		yes							600 per month	
2		44	x		yes			urine is diverted to a soft pit				360 per month	
1 planned, 1 built		6			yes					180	90	500 per month	

11. Curriculum Vitae

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EDUCATION AND QUALIFICATIONS

10. 2007 to present	Master's programme; Environmental Engineering, University of Natural Resources and Life Sciences, Vienna
03. 2006 – 02. 2007	Civil Engineering Tri-national, Karlsruhe University of Applied Sciences (Germany)
10. 2004 – 07. 2005	Civil Engineering Tri-national, University of Applied Sciences Basel (Switzerland)
10. 2003 – 07. 2004	Civil Engineering Tri-national, L'Institut Universitaire de Technologie Robert Schuman, Université de Strasbourg (France)
	02. 2007 Graduate Civil Engineer (CH) 02. 2007 Bachelor of Civil Engineering (D) 02. 2007 Licence Professionelle (F)
2001 – 2003	Hansa-Gymnasium, Stralsund
2000 – 2001	Northcliff High School, Johannesburg (South Africa)
1994 – 2000	Hansa-Gymnasium, Stralsund

RELEVANT WORK EXPERIENCE

2007	three-month work experience in a joint project of GTZ and Dornier Consulting, title: “Development of a master plan for the sewerage network of Abu Dhabi”, Abu Dhabi, United Arab Emirates
2005	six-month work experience as construction manager; Bilfinger Berger GmbH Freiburg, construction site: Nouveau Hôpital Civil Strasbourg, France
2004	two-month construction work experience; RIPEAU–MARTEL S.A.R.L (renovation and restoration), La Rochelle, France
1999	two-weeks laboratory work experience; Industry- and Environment-laboratory Western Pomerania GmbH, Stralsund, Germany

FOREIGN LANGUGES

English: good, French: good

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AUSBILDUNG UND ABSCHLÜSSE

10. 2007 – 07. 2011	Masterstudiengang Kulturtechnik und Wasserwirtschaft, Universität für Bodenkultur Wien
03. 2006 – 02. 2007	Bauingenieurwesen Trinationales Studium, Hochschule – Technik und Wirtschaft – Karlsruhe (Deutschland)
10. 2004 – 07. 2005	Bauingenieurwesen Trinationales Studium, FHBB Basel (Schweiz)
10. 2003 – 07. 2004	Bauingenieurwesen Trinationales Studium, IUT Straßburg (Frankreich)
	Akademischer Grad: Diplom Ingenieur in Bauingenieurwesen FH (CH) Bachelor of Civil Engineering (D) Licence Professionelle (F)
2001 – 2003	Hansa-Gymnasium, Stralsund
2000 – 2001	Northcliff High School, Johannesburg (Südafrika)
1994 – 2000	Hansa-Gymnasium, Stralsund Allgemeine Hochschulreife

PRAXISERFAHRUNG:

2007	dreimonatiges Praktikum in einem Gemeinschaftsprojekt der GTZ und Dornier Consulting („Master Plan for the Sewerage Network in Abu Dhabi"), Abu Dhabi, Vereinigte Arabische Emirate
2005	sechsmonatiges Praktikum in der Bauleitung; Bilfinger Berger GmbH Freiburg, Baustelle: Nouveau Hôpital Civil Straßburg, Frankreich
2004	zweimonatiges Baupraktikum; RIPEAU – MARTEL S.A.R.L (Renovierung und Restauration), La Rochelle, Frankreich
1999	zweiwöchiges Laborpraktikum; Industrie- und Umwelt-Laboratorium Vorpommern GmbH, Stralsund

FREMDSPRACHENKENNTNISSE:

Englisch:	gut in Wort und Schrift
Französisch:	gut in Wort und Schrift

Stand: März 2011