MAPET

A neighbourhood based pit emptying service with locally manufactured handpump equipment in Dar es Salaam, Tanzania

MAPET project

Final report

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1988 - 1992

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The research for this publication was financed by the Netherlands' Minister of Development Cooperation.

Code: MAPET 92

TABLE OF CONTENTS

ACKNOWLEDGEMENT

Jan van Uden (1947 - 1992)

The MAPET project's approach and achievements in Dar es Salaam have at times been qualified as 'typical WASTE'. Often the personification of this was Jan van Uden, the technical consultant of the project: full of enthusiasm, full of belief in local opportunities and trust in informal relationships. For him, every human being disregarding their trade and status was a potential contributor to progress in general and to the project in particular.

Jan paid his last visit to Dar es Salaam in March 1992, still unaware of the cancer that was killing his strong body. He passed away on July 9, 1992. He is greatly missed by his friends and colleagues of the MAPET project, as it was and still is.

Jasper Kirango (Head of Dept, DSSD), Emelda Mwakifitna (MAPET field coordinator, WASTE), Xavier Haule (MAPET mechanic, DSSD), Yahaya Maftaha (private MAPET emptier), Maria Muller (sociologist, WASTE) Jaap Rijnsburger (project leader, WASTE)

ABBREVIATIONS

BRU	Building Research Unit
CBO	Community Based Organisation
CCM	Chama Cha Mapinduzi (the political party in Tanzania)
COMPET	Comparative Study on Pit Emptying Technology
DGIS	Directoraat Generaal Internationale Samenwerking (Directorate General for International Cooperation of the Netherlands Ministry of Foreign Affairs)
DSSD	Dar es Salaam Sewerage and Sanitation Department
IRCWD	International Reference Centre for Wastes Disposal
LCS	Low-cost sanitation
MAJI	Ministry of Water of Tanzania
MAPET	Manual Pit latrine Emptying Technology
MSTS	Mobile Sludge Transfer System
NGO	Non Governmental Organisation
SIDO	Small Industries Development Organization
WASTE	WASTE Consultants on Appropriate Technology

SOME DEFINITIONS

Informal pit emptying business

Business refers to the economic activity of emptying latrine pits for customers. It is *informal* because the business and its turnover are not registered or regulated. Informal pit emptying business (traditional as well as MAPET) is carried out by a cooperation of self-employed pit emptiers: one leader with usually two helpers. Informal business as used in this report thus includes the connotations *small* and *private.*

MAPET equipment unit

Complete set of manual pit emptying equipment, consisting of handpump cart, vacuum tank-cart, air hose-pipe, sludge hose-pipe and mixing rod. During the project two types of tank carts were developed. The *standard type* has an exchangeable 200 litre drum shaped sludge tank. The *Kibuyu* has a low point of gravity, with a gourd shaped tank, integrated in the cart frame. Kibuyu is the Kiswahili name for 'gourd'.

Neighbourhood based or community based pit emptying services

The expression *neighbourhood based* refers to the *geographical* delimitations of the pit emptying services, meaning that the services are relevant to the neighbourhood concerned and are available at the request of customers living in that neighbourhood. *Community based* goes further than that. Community based pit emptying services meet the *demand* as expressed by the community, including mechanisms through which community members have *influence* on the availability and performance of the services, exercised by a leader or committee, or through social control on pit emptiers living in the community.

Transfer station

Tank in which latrine sludge can be disposed and temporarily stored before haulage into the final disposal station takes place. There are two types of transfer stations: a *fixed* transfer station and a *mobile* transfer station. A fixed transfer station is a subsurface concrete tank for disposal and temporary storage of sludge, to be collected by a *vacuum tanker.* A mobile transfer station is a tank vehicle used as neighbourhood disposal point, which also hauls the sludge to the final disposal.

Unplanned areas

The *unplanned* areas of Dar es Salaam are mostly low-income residential areas that have grown without planning before construction. As such, they lack any physical infrastructure such as roads, drainage and sewerage. Piped drinking water and electricity are brought in afterwards on an ad hoc basis, by individual residents who can finance the commodity. In Tanzania the

expression *unsurveyed* areas is also used, referring to the land planning process that has never taken place. Internationally, the expression *squatter* areas is most commonly used. That, however, has the connotation of poor housing which is not typical for Dar es Salaam. The quality of housing and the facilities such as pit latrines is relatively good, not worse than in planned areas. It is the lack of public infrastructure which is more typical. Throughout this report the term *unplanned areas* is therefore used, with the understanding of being inhabited by *low-income* residents.

Vacuum tanker

Motor vehicle equipped with vacuum pump and tank, for the emptying or desludging of pit latrines, septic tanks or sewers, and *sludge haulage* into a disposal station. Conventional vacuum tankers are built on a regular 10 ton truck chassis, with a sludge hauling capacity of 4 - 6 m^3. Mini tankers have a small chassis, with a sludge hauling capacity of 2 m^3 or less.

SUMMARY

Background

Between 1988 and 1992 the Netherlands Minister of Development Cooperation financed a project for the development of a pit emptying technology suitable for the low-income, unplanned areas of Dar es Salaam, Tanzania: the Manual Pit Emptying Technology (MAPET) project. Project objectives were:

- To contribute to the improvement of environmental sanitation in unplanned areas by facilitating an effective and hygienic pit emptying services
- To improve the informal traditional pit emptying method by making it more efficient and hygienic.

The project partners were WASTE Consultants, Gouda, The Netherlands, and the Dar es Salaam Sewerage and Sanitation Department (DSSD), Dar es Salaam, Tanzania.

As in many other cities in low-income countries, Dar es Salaam has a problem with full pit latrines. When pit latrines are not emptied in time, they pose a health hazard to the population. The project was based on the following observations:

- 80% of the population relies on on-site sanitation, mainly pit latrines
- Conventional pit emptying services, using vacuum tankers cannot supply to unplanned areas
- Traditional manual pit emptying is expensive and unhygienic.

Project approach

Four features characterized the project approach:

- Participatory development and technology introduction
- Combining elements of technologies that are familiar to small workshops in Tanzania
- Pit emptying as self-employment linked to the public sector
- Intermittent presence of consultants and reliance on expertise available at DSSD.

Technology

The design criteria and decisions are the outcome of the general objective that the equipment should not be dependent on imported fossil fuel, be small enough to be pushed through the narrow paths of the unplanned areas, and be of a kind that can be manufactured in Tanzania with locally available expertise, tools and materials.

Through technology development the MAPET equipment came to consist of the following parts:

- A piston handpump mounted on a pushcart
- A 200-litre vacuum tank mounted on a pushcart
- A 3/4-inch air hose-pipe between the pump and the tank, and a 4-inch sludge hose-pipe to drain the sludge from the pit

– Auxiliaries like a rod for sludge mixing.

Maintenance of the equipment was ensured by applying construction techniques generally known and applicable in large and small scale workshops in Tanzania, and by training DSSD mechanics in the construction and repair of specific MAPET components.

Customers, the community and gender aspects

By means of two social surveys and meetings with leaders, women and other residents, the following customers' criteria for satisfactory pit emptying services were discovered:
– Good quality (no waiting time)
– The cost should be affordable and fit in with a household expenditure pattern of buying goods and services in small quantities
– Social accessibility (direct negotiations with pit emptiers)
– Physical accessibility (booking office in own neighbourhood)

The MAPET services are community based in that they serve the residents of a delimited neighbourhood, can respond to the demands of residents and community leaders, and has the equipment stationed within the neighbourhood.

Women benefit from improved environmental health conditions. They can also influence service delivery as the booking office is located in their neighbourhood.

MAPET and informal self-employment

The MAPET pit emptiers are self-employed. They determine their own team composition and work routine, set their own price level through negotiations with the customers, and decide how to share their income among themselves. They lease the equipment from DSSD. Employment is also created in the informal workshops where MAPET components are manufactured and repairs are carried out.

Enabling support for decentralized public services

DSSD, as the public agency responsible for pit emptying, has provided enabling support for the establishment of the decentralised MAPET services. The following elements of enabling support were identified:
– Creation of a suitable policy atmosphere
– Interdepartmental cooperation
– Training of pit emptiers, mechanics and staff members
– Monitoring the performance of the services
– Transfer, disposal and treatment of sludge
– Facilitating access to financial resources, including supply and maintenance of equipment
– Service promotion and health education
– Establishing operational links between the decentralised services and the central organization.

MAPET in the urban sanitation system

MAPET applies the traditional method of disposal and treatment by burying the sludge.

When the MAPET services expand to other areas, a system of off-site sludge treatment must be developed. This will involve the use of transfer stations as well tank vehicles that will haul the sludge to one of the sewage treatment ponds.

Conditions for sustainability

The following conditions for sustainable MAPET pit emptying services have been identified:
- The equipment must be kept operational
- Public hygiene standards must be maintained
- The scheduling of customers must be efficient
- Cost recovery must be improved.

CHAPTER 1 INTRODUCTION

1.1 Project history

Between 1988 and 1992 DGIS, the Netherlands Ministry of Development Cooperation, financed a technology development project in Dar es Salaam, Tanzania. The project was initiated in 1985 by WASTE Consultants in cooperation with DSSD, the Dar es Salaam Sewerage and Sanitation Department. It became known as MAPET, an acronym for *manual pit latrine emptying technology*, after the handpump equipment that facilitates pit latrine emptying in unplanned areas.

The objectives of this technology development were to contribute to the improvement of environmental sanitation in unplanned areas on the one hand, and of the informal practice of traditional pit emptying on the other hand. The improvement of environmental sanitation aimed at facilitating effective and hygienic pit emptying services. The improvement of the traditional pit emptying practice aimed at hygienic working conditions with locally available technology.

Although the pilot project was originally meant to develop and field-test a technology, it has achieved more. By the end of the project period in 1992, seven teams of private pit emptiers were active in several unplanned areas of Dar es Salaam, three of them with a continuity since 1989. In two unplanned areas, Mwananyamala and Mburahati, MAPET established itself as community based pit emptying services. The MAPET services and technology were transferred to a team in Morogoro, which was equipped and trained by MAPET mechanics and emptiers from Dar es Salaam. What started as technology *development* thus became a *pilot implementation* project.

1.2 Project team

The project was executed by a local team in Dar es Salaam and supported by WASTE Consultants during short visits. The local team consisted of a DSSD staff member (i.e. the Head of the Low-Cost Sanitation Division), the MAPET coordinator and two MAPET mechanics, with occasional assistance of other LCS staff members, and a sanitation technician. The latter was first seconded by the Ministry of Water (MAJI), later contracted by WASTE Consultants. WASTE Consultants rendered its support through a physical planner (also project leader), a technician and a sociologist. For the particulars of all the staff members involved, see Annex II.

1.3 Project means

The original MAPET project provided the means for:
- Prototype development of manual pit emptying equipment
- A household survey
- Field trials
- Construction (largely local) of four handpump equipment units
- Procurement of the essential commodities for pit emptiers and mechanics: bicycles, protective clothing and tools
- Expert support by WASTE Consultants

The trial construction of a so-called fixed transfer station in Manzese was paid for as a Small Embassy Project.

Another DGIS financed project, the Comparative Study on Pit Emptying Technologies or COMPET project (1991-1993), provided additional means for:
- The local construction of six more units of handpump equipment
- The construction of another fixed transfer station in Mwananyamala A comparative study on the operational performance of the three pit emptying technologies (large vacuum tankers, small vacuum tankers and MAPET); a survey of customers' opinions about these technologies; a technical investigation; and an institutional description.

These means altogether enabled seven informal businesses to operate MAPET emptying services. The present report comprises experiences and achievements till July 1992. It includes COMPET data on the operation of the MAPET services and on customers' opinions.

1.4 Project activities

The project activities can be grouped in six categories: *technology, customers and community, informal business, institutional framework* and *sanitation system.* The chapters with these titles form the body of this report.

Technology
- Prototype development of small and manually operated pit emptying and sludge transfer equipment
- Field testing and adjustment of prototype equipment
- Identification of local manufacturing capabilities
- Technology transfer to and training of local mechanics
- Local construction of 10 equipment units

Customers and community
- Identification of customers' opinions, demands and criteria
- Information, promotion and demonstration of the MAPET services
- Introduction and operation of the MAPET services in the unplanned areas of Manzese, Temeke, Mwananyamala, Mburahati, Kinondoni, Buguruni and Mtongani
- Identification of gender aspects

Informal business
- Identification of the traditional pit emptying system through pit emptiers' survey
- Development of working routines
- Identification of cost elements and cost recovery procedures
- Training of emptying teams
- Continuous operation by five teams (three since 1989, two since 1990), based in Mwananyamala (2), Mburahati (2) and Buguruni (1)
- On and off operation by two teams in Temeke and Mtongani
- Establishment of a team in Morogoro

Institutional framework

- Identification of DSSD support to MAPET teams and communities
- Development of promotion and information routines
- Trial with loan and reimbursement procedures

Sanitation system

- Identification of sludge transfer and treatment system elements
- Development of and trial with pit emptying and sludge disposal routines
- Transfer station design and trial construction
- Identification of public monitoring and control

CHAPTER 2 PROJECT SETTING

2.1 Par es Salaam

Dar es Salaam is the largest city and former capital of Tanzania. In 1988 the country had a population of 23.2 million with an average growth rate of 2.8% over the previous decade[1]. Being one of the poorest countries in the world and since there is a structural adjustment programme going on, government finance for public services is dwindling.

In 1988 Dar es Salaam had a population of 1.36 million. With an average growth rate of 9.7%, it is estimated that the city's population had reached 2 million by 1992. Several parts *of* Dar es Salaam are connected to a centralized sewerage network. They can be found in the city centre, the industrial areas and in a few residential areas. The sewer systems are linked to sewage treatment ponds where the organic matter is being treated. There are five such sewage treatment ponds in Dar es Salaam. The sewers and the sewage treatment fall under the responsibility of the DSSD. The sewage treatment ponds also serve as dumping stations for the vacuum tankers used by the DSSD to empty pit latrines and septic tanks. Despite the recent extension of the sewerage network with a World Bank loan, the major part of the city is not connected to sewerage. Especially the low-income households in the large unplanned or squatter areas depend on on-site sanitation: pit latrines and septic tanks.

2.2 Pit latrines

There is a strong tradition of on-site sanitation in Dar es Salaam. Actually 80% of the houses in all of Dar es Salaam have a pit latrine[2]. Although traditionally pit latrines in Dar es Salaam are large (10 m^3 or more), due to clogging of the soil, most pits fill up within 5 years after construction, and start overflowing. The overflowing pit latrines are a threat to the public health. The fresh leachate from pit latrines causes the spreading of diarrhoeal diseases like cholera, and infections like hookworm. Officially a new pit must be dug when the sludge in the pit has reached a level of 3 ft under the subsoil[3]. Most houses however, lack the space to shift the toilet to a new pit. Moreover, the construction costs of pit latrines, which in the coral sand of the East African coast have to be fully lined with blocks to prevent collapsing, are very high. In these situations full pit latrines need to be emptied.

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1 *1988 Population Census, Bureau of Statistics, Ministry of Finance, Economic Affairs and Planning, Dar es Salaam, 1989*

2 *Hoek-Smit, The Urban Housing Sector in Tanzania - Part I, Statistical Analysis of the Urban Housing Survey - Draft, The World Bank, 1991*

3 *The Township Ordinance, Rules and Building Rules (Cap 101) did not foresee the possibility of pit emptying.*

From the 1989 Social Survey

In Manzese almost all (94%) of the residential plots had a pit latrine. On average five households live on a plot, while the average household consists of four people. In practice, the number of people using the one latrine on a plot range from four to 40 (with an average of 16). The pit latrines are on average almost 8 years old, with 20% having been constructed 12 or more years ago. The most common pit contains 10 m^3 (10,000 litres). In many cases the pit's contents are liquid as the latrine is also used for bathing or for the disposal of household wastewater. In some cases the contents are very heavy because solid materials like soiled children's clothes, garbage, stones or coconuts are thrown into the pits.

2.3 City Council pit emptying services

The responsibility for environmental sanitation in Dar es Salaam is divided between the Dar es Salaam Sewerage and Sanitation Department (DSSD) and the Health Department. The DSSD has been newly established for sewerage and pit emptying by the Central Government (Ministry of Water), through a World Bank project (1982 - 1988), while the Health Department maintained the functions it already had: solid waste collection and disposal, pit emptying, health inspection, city hospitals and public health campaigns. Both the DSSD and the Health Department have a depleting fleet of large vacuum tankers that are used to empty septic tanks and pit latrines. Maintenance of these vacuum tankers is a problem, largely related to the high cost of imported spare parts. Long delays in repairs are very common, and the cannibalizing of broken down vehicles to obtain usable spares is a regular practice. The result is an increasing shortage of tanker capacity.

The vacuum tankers are mostly used for services to the planned areas where the septic tanks and pit latrines are easily accessible. Many of the residents living in the unplanned areas cannot be serviced, as the roads are poor and paths too narrow to be accessed by the tanker trucks.

2.4 Traditional emptying

Residents in the unplanned areas had only one option before: the practice of traditional emptying. They could hire casual labourers (called *vyura:* frog men) to empty the pit latrine manually with hand tools borrowed from the customer.

From the 1989 Social Survey

> Traditional pit emptying is casual work which is supplemented by earnings from informal trading, farming and work in the construction industry. It is performed by one experienced leader who is assisted by one or two casual helpers with whom he does not form a permanent team. An emptier does not own the tools he uses, such as a bucket, a hoe, a rope and a spade, but he borrows them from the owner of the latrine. An emptier finds his customers through informal personal contacts. The price is negotiated between the emptier and the customer. They also agree on how the payment is made, with the larger part of the fee to be paid after the job is completed and sometimes in instalments. It is these informal, personal aspects of traditional pit emptying that people say they like. A traditional emptier earns on average the TSh equivalent of $30 per 'job'. He may charge, however, up to $60 or $70 if the work is laborious and heavy.

Two different traditional emptying routines have been identified: *scooping* and *flushing*. With scooping the emptiers break open the squatting slab and scoop out the pit from the inside. This is all done manually. The sludge is then buried in a large hole dug on the customer's compound. With flushing the sludge is flushed into an adjacent hole that is deeper than the pit latrine.

The traditional emptiers, who are in full contact with the sludge, consider the work to be unhygienic and often dangerous. They therefore want to be paid well. For these reasons and because of the low social status of the work, the traditional emptiers perform this work part-time, not more than once or twice per month.

The traditional pit emptying method has more disadvantages. It takes a long time, two to seven days during which the residents have an uncovered pit latrine and disposal hole on their compound, which is inconvenient and even dangerous. Hiring traditional emptiers is also quite costly. The traditional practice involves demolishing the squatting slab or the pit lining and often the toilet superstructure, which is only worthwhile if the whole pit is emptied.

Not all residents in the unplanned areas use the practice of traditional emptying. A recent survey[4] in one of the unplanned areas of Dar es Salaam shows the existence of very large pits (up to 40 m^3), many of them appear to be full to the brim, none of them ever being emptied. As a result, many pits are continuously overflowing and contaminating the environment.

2.5 International context

It is only quite recently that pit emptying and the need to develop appropriate solutions for urban sanitation, received recognition, particularly through the efforts of the International Reference Centre for Wastes Disposal (IRCWD) in Duebendorf, Switzerland. The requirements and specifications for vacuum tankers were assessed during field trials in Botswana in 1983. In collaboration with a manufacturer (MCA, Ireland), a mini tanker was developed and tested in Nairobi for the World Bank/UNDP TAG group. Two of these mini tankers were put on trial in

[4] *Preliminary findings in 1992 during a survey for 1DRC, executed by the Department of Environmental Engineering of the Ardhi Institute in Dar es Salaam*

Dar es Salaam during the COMPET study. WASTE Consultants took up the development of a manual pit emptying technology for application in areas not accessible to tanker vehicles.- The Comparative Study on Pit Emptying Technologies (COMPET) in Dar es Salaam (1991 - 1992) assessed the operational criteria for the complementary input of the three technologies (large tanker, mini tanker and MAPET)[5].

[5] *Proceedings COMPET Seminar, Dar es Salaam, March 1993*

CHAPTER 3 PROJECT APPROACH

3.1 Participatory development

A participatory approach was applied whereby the MAPET technology and services were developed in response to the experiences and comments of the people most directly involved in using the equipment, i.e. pit emptiers, DSSD mechanics, businessmen in the informal sector, and residents.

Pit emptiers

WASTE Consultants cooperated closely with the first MAPET emptiers and mechanics. As soon as the first prototype equipment was operational, two traditional emptiers were interested to test the equipment in real-life conditions, finding their customers in the manner they were used to.

The comments made by the emptiers about the functioning of the machinery proved most valuable, and led to the adjustment of essential parts of the equipment. For example, difficulties experienced by the emptiers led to modifications to the 200-litre oil drum. And when the emptiers had demonstrated how they stirred and liquified the sludge, the WASTE consultant designed various tools. The emptiers tried them all and decided which one was the best to facilitate the process.

Mechanics

The DSSD mechanics participated in the discussions with the emptiers and together they decided on practical solutions. The mechanics shopped around for materials and components that were available in the informal sector. With that information in mind decisions were made about, for example, the use of a particular type of sheet metal for constructing the frame of the pushcarts.

Informal sector

Informal sector ‘jua kali') workshops were identified for the manufacturing of rubber products, such as sandals and spare parts for machinery. These workshops were asked to experiment with the parts needed for the MAPET pump (e.g. ball valve and piston seals). In this way, the limitations to manufacturing done by informal workshops became known.

Also, responding to the challenge of an informal sector mechanic that he himself would be able to manufacture the MAPET pump cart, he was given the assignment. The mechanic succeeded very well, having observed the process in the DSSD workshop and using his connections in both the formal and informal sector to obtain the spare parts he needed.

Residents

When looking for the first customers to test the equipment, it became clear that public promotion of the MAPET services was necessary. The project team decided to visit the CCM branch leaders and to talk with women's groups. During these meetings people made suggestions, about how to introduce the services and attract more customers. They suggested activities that were familiar to them, such as holding a series of branch meetings, providing written information, identification cards for the emptiers, and a financial bonus per customer identified by a local official or women's group. All of these activities were put to the test in the MAPET promotion routine.

One of the actions taken by WASTE Consultants was the dissemination of a one-off edition of a MAPET Newsletter (in Kiswahili and English) with information about MAPET operations and with pictures of the emptiers and project staff. Copies were handed out in the CCM branches and delivered at meeting places such as the health clinic, schools, and ward and branch offices.

These successful promotion activities resulted in community leaders putting pressure on DSSD to extend the MAPET services.

3.2 A combination of technologies

Elements of both the traditional and the modern pit emptying technologies with which people are familiar, were combined. From the traditional technology the manual operation (to reduce dependence on imported fossil fuel) was adopted, and the burying of sludge on the customer's plot as a locally accepted method of disposal and treatment. From the modern technology, the vacuum principle and the piston pump that are used in rural water supply methods, were adopted.

The MAPET technology, moreover, uses locally available parts and materials and relies on the most common practices in workshops, which often do not have drills and hacksaws. Cutting metal, for example, is done by means of burning, using a gas welder. This ensures that MAPET equipment can be manufactured and maintained in Tanzania.

This combination of elements has made the MAPET services both familiar and a means of increasing the social status of pit emptying in the eyes of the pit emptiers and neighbourhood residents.

3.3 Intermittent presence

To a large extent the pilot project relied on expertise available in DSSD, while WASTE Consultants provided assistance during short missions only. The DSSD's Head of Department and the Head of the Low-Cost Sanitation Division participated actively in project developments. The DSSD also made workshop mechanics available as well as a field coordinator. The Ministry of Water (Department of Sewerage and Drainage) seconded a sanitation technician, a woman, to the project.

During the first four months of the project, WASTE Consultants had a technician and a project assistant posted in Dar es Salaam to develop and test the MAPET equipment under field conditions. After this, the technician returned three times a year to monitor the performance of the equipment, decide on improvements, and to support the development of a neighbourhood organization of the MAPET services. During these short missions the technician was either joined by the WASTE Consultants' planning engineer or the sociologist. The consultants discussed with the pit emptiers and the staff members the experiences they had had, tried out their suggested solutions to problems, and agreed with them on their tasks for the next three to four months. These insights fed the discussions with the DSSD management and government officials about the integration of MAPET in the formal framework for sanitation services in Dar es

Salaam. This work style ensured that the development of the MAPET equipment and the MAPET services responded to local conditions.

3.4 Project sequence

These principles of the project approach resulted in a programmatic development of the project.

During the first period (the test phase) the focus was on technology development. A prototype diaphragm handpump was developed and tested in the Netherlands and shipped to Dar es Salaam. A second diaphragm handpump was constructed as well as a prototype piston pump. This was done together with three DSSD mechanics.

At the same time a socio-technical survey was conducted in Manzese, a densely populated, unplanned area in Dar es Salaam[6]. Interviews were held with residents about sanitation practices, the construction and operation of pit latrines, their views on the traditional emptying methods and the DSSD services, and on the cost of traditional pit emptying. Extensive interviews were also held with traditional emptiers, community leaders and women's groups.

The decision to involve traditional pit emptiers in field testing the equipment, necessitated the early introduction of enabling support to the pit emptiers. This support comprised MAPET demonstrations in the residential areas, and experiments with a system of leases and loans operated by the DSSD. The development of this type of support had been planned for a follow-up pilot project.

The need for a sludge transfer station was also identified in this early stadium of the project. Although MAPET was intended to provide services only in areas with a low groundwater table, the urgent demand of residents in waterlogged areas for MAPET pit emptying, was taken up by the project team. Sludge transfer stations were considered, from where sludge is hauled to a final disposal and treatment facility. Sludge transfer provides an alternative to the burial of sludge on residential plots. Investigations about the technical and planning possibilities for transfer stations led to the construction of two fixed sludge transfer stations.

The remaining project period focused on the development of several components of the MAPET services. Technology development resulted in essential improvements of the equipment, experience was gained with strategies to promote MAPET in neighbourhood communities, and experiments with financial and institutional arrangements between DSSD and the independent pit emptiers were carried out. Also preparations were made to introduce mobile sludge transfer stations because it was almost impossible to get planning permission for the fixed stations.

At the end of the project period a second social survey was executed (1991/1992)[7]. Residents were specifically asked about their experiences with all available emptying services in Dar es Salaam, such as MAPET, the DSSD vacuum (large and mini) tanker services, and the traditional method.

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[6] *Social Survey on Pit Latrine Emptying in Dar es Salaam, Tanzania, MAPET Progress Report 6, 1989*
[7] Comparative Study of Pit Emptying Technologies, Customers' Survey, 1993

CHAPTER 4 THE MAPET SYSTEM: AN OVERVIEW

4.1 MAPET equipment

The MAPET equipment has two main components: a handpump and a 200-litre vacuum tank, both mounted on pushcarts. Two flexible hose-pipes belong to the equipment, i.e. a 3/4-inch hose-pipe as air connection between the pump and the tank, and a 4-inch hosepipe of 4 metres to drain the sludge from the pit. A Bauer clamp-coupling connects the sludge hose-pipe to the tank.

Picture 1 *The MAPET equipment is manufactured in Dor es Salaam. By constructing local mechanics acquire the know-how for maintenance.*

There are several auxiliaries: a mixing rod for stirring the sludge to the required viscosity, a hook for picking rags and other material that blocks the flow of the sludge, a spade and a hoe for digging the hole for sludge disposal, a chisel and a hammer for widening the squatting hole or making a hole in the latrine wall for the sludge hose-pipe.

4.2 MAPET teams

A team of MAPET emptiers consists of three men, each of whom is self-employed. The team leader selects his own team members. Together they decide on how to cooperate in the work and how to share the income they earn as a team. They depend on their own efforts to find work. Each team has its own territory.

4.3 MAPET emptying routine

The emptying job starts with contacting the customer, negotiating over the price, picking up the MAPET equipment from its parking place and taking it to the customer's house. The latter may take from 30 to 60 minutes. A hole is dug for sludge disposal and the latrine sludge is prepared for pumping. This preparation entails mixing the sludge with water (to make it more fluid) and paraffine (to reduce the smell). After the hose-pipes have been connected the sludge pumping can start. Depending on the sludge's viscosity and the pumping head, it can take five to twenty minutes to fill up one 200-litre tank with sludge.

Picture 2 *The equipment is small scale, a requirement for access to full pits in unplanned areas.*

When a tank is full, the hose-pipes are disconnected and the tank is manoeuvred next to the dug hole, and topped over in discharge position. A pressure relieve valve is opened and the sludge

flows into the hole. After putting the tank back in its original position, pumping can start anew and the vacuum tank is filled again. This routine is repeated until the required amount of sludge has been taken out. The equipment is then cleaned and returned to the neighbourhood parking place.

4.4 Sludge disposal

Two ways of sludge disposal are practised, the one most often applied is on-site disposal. It takes place when the water table is low and when there is sufficient space on the plot. Off-site disposal (not much practised as yet) takes place when the water table is too high or when the plot has no space for on-site disposal.

Picture 3 *Compared to traditional emptying MAPET has improved the hygiene on the compound and the working conditions for the emptiers.*

On-site disposal implies burying the sludge on the residential plot itself. The team has to return after one or two days to fill up and cover the hole containing the sludge. The sludge has to be left some time to allow leaching of the liquid before the sludge can be covered with soil.

When off-site disposal is necessary, the sludge has to be transported to a permanent or temporary disposal site somewhere in the neighbourhood. To make off-site disposal a regular practice, a system of sludge transfer and treatment is necessary.

4.5 Institutional setting

DSSD gives enabling support for the MAPET services. Enabling support consists of four main elements:

- DSSD provides the training and licensing of pit emptiers as a condition for their use of MAPET equipment.
- DSSD is the manufacturer of the MAPET equipment and carries out major repairs. It leases or lends the equipment to the MAPET teams.
- DSSD engages in active promotion of MAPET in selected areas in order to create sufficient demand for pit emptying and to ensure business continuity for the teams.
- DSSD is responsible for monitoring the pit emptying performance of the MAPET teams in practice and for adjusting malpractices.

Community leaders play intermediary roles. They give permission to park the MAPET equipment at the CCM branch office (for security reasons), and they assist with contacting customers and monitoring the MAPET emptiers' performance. Finally, they have put pressure on DSSD to ensure the continued operation of a MAPET team in their area.

Picture 4 *On-site disposal in a dug hole on the customers' compound, by tipping the 'Kibuyu'*

CHAPTER 5 TECHNOLOGY

5.1 Design criteria

The following design decisions were made for the development of the pit emptying equipment:

Criterion	*Design decision*
Reduce dependence on expensive imported fossil fuel	Human powered equipment: – Handpump emptying – Pushcart transport with an operating base close to the customers –
No demolition of squatting slab and super structure	Excavating the sludge through the squatting hole by means of a hose-pipe
No sludge entering the pump to prevent risk of blockages and heavy wear	– Indirect pumping, creating a vacuum in a tank which draws sludge – A gauge to control sludge level (looking glass)
Optimal use of human power for a pumping head of max 3 m	Approximate dimensions: – Flywheel diameter: 80 cm – Rotation speed: 40-60 rpm – Pump volume per stroke: 2.0 litres – Mass of flywheel: 25 kg –
Accessibility through small paths and gates to inner courts	Maximum width: 800 mm (relates to the wheelbase of the carts and the flywheel diameter)
Local construction and maintenance in Tanzania	Applying locally available technologies and skills for: – Drinking water handpumps and piped water supply – Motor vehicle maintenance – Bicycle maintenance –
No expensive, vulnerable gate valves	Tipping of the tank: – Coupling position 'up' for pumping and manoeuvring – Coupling position 'down' for discharge

5.2 Local development

Prior to the start of the project in Dar es Salaam, prototype sludge handpumps had been

constructed in the Netherlands where several tests had been done on two types of pumps: a piston-pump and a diaphragm-pump. A prototype diaphragm-pump was shipped to Tanzania where the first complete MAPET pump unit was locally completed with a modified oil drum as a tank and a handcart for transport. With this unit, two traditional emptiers set up a MAPET team.

The MAPET equipment can entirely be assembled in Tanzania with local supplies, except for the leather piston ring. Despite efforts to interest a local manufacturer, this part has to be imported from the Netherlands. Two other parts, the flexible sludge hose-pipe and the standard DSSD hose-pipe couplings, can be supplied locally, but at high costs. Rubber parts are made by small, informal workshops, while precision wood work (e.g. bearings) are ordered with the Building Research Unit (BRU). Metal components for the handpump (e.g. the flywheel drive) and the vacuum tank are made by the central facilities' workshop of the Small Industries Development Organization (SIDO). The DSSD workshop mechanics assemble the components into a full set of MAPET equipment.

The costs for single construction of a complete MAPET unit proved to be the equivalent of $ 3,000. These include:
- Manufactured components;
- Readily bought components;
- Consumables (gas, welding rods, paint);
- Transport: to obtain materials and quotations, to follow-up orders, collect components;
- Incentives for DSSD mechanics.

5.3 Handpump

Since drinking water technologies are applied on a much larger scale in Tanzania than vacuum or pneumatic technologies, the MAPET handpump technology uses parts, e.g. valves, piping, that are also used in the regular local drinking water technology. The vacuum pump is applied indirectly. By pumping air, it creates a vacuum in a connected container. In this way no sludge passes through the pump, making it less vulnerable to wear and tear.

The diaphragm-pump proved to be less suited to the local situation than the piston pump. The most vulnerable part in the diaphragm-pump is the rubber diaphragm. Even imported heavy duty diaphragms started cracking and leaking after a few months, due to the operational circumstances (UV radiation) and the tension in the rubber related to the necessarily large strokes.

The diaphragms that were obtained locally from a Tanzanian rubber factory were too small for the MAPET application, and of less quality. To order diaphragms of a larger size was not feasible, considering the high costs of the mould that had to be imported.

Eventually a piston-pump with a leather piston in a 6-inch PVC cylinder became the standard MAPET pump. The PVC cylinder is made out of sewage piping, readily available at the DSSD. The piston leather is still imported from the Netherlands to Tanzania. So far, no leather workshop in Tanzania has been found interested in its production, although it can be produced by the piece in a small-scale artisan workshop, modelled on a relatively cheap wooden mould, as it is done in

a workshop in the Netherlands'. The leather piston is not as vulnerable as the diaphragm however. It only needs to be replaced once a year.

5.4 Vacuum tank

The first MAPET units were equipped with a 200-litre oil drum as sludge container. During the field-tests it became evident that it was prone to corrosion. When it was put under vacuum-pressure, it could also implode. The critical point was around a pressure of -0.4 bar, a pressure regularly achieved during the operation of a MAPET unit. Welding reinforcement bars on the tank surface made it even more vulnerable to corrosion. A major constraint of reinforcement inside the tank was that it aggravated clogging with rags and sand.

It was then decided to weld a tank out of 3 mm sheet metal. The contents of the tank remained the same (200 litres) but the diameter was decreased, enabling the tank to be fitted in between the wheels of the cart, without exceeding the maximum width of 80 cm. This had the advantage of lowering the centre of gravity of the tank cart, and thus making it easier to manoeuvre along the narrow and often sandy streets of the unplanned areas of Dar es Salaam. This became the standard type vacuum tank.

Several designs were made of the tank to improve its ergonomics. Attention was given to its performance regarding transportation, steering and tipping. The current design is known as the *Kibuyu*, which is the Kiswahili name for gourd, reflecting the shape of the tank. The Kibuyu tank has many advantages.

Because of its better diameter/length ratio the expensive sheet metal can be cut more efficiently. The tank dimensions enable a lower centre of gravity, making the handling of the pushcart much easier. Its gourd shape improves the sludge flow when emptying into the disposal hole, and less sand remains in the tank. Because of its improved diameter/length ratio the Kibuyu also *looks* smaller than the standard tank. At first customers found it hard to believe that it can contain as much sludge as the standard tank or oil drum they were used to. For this reason pit emptiers had to prove that it really can contain 200 litres. A proof which could only be given by filling it with 200 litres of expensive water.

5.5 Carts and wheels

The first MAPET pump and 200-litre drum were transported on a hired handcart (mkokoteni). Because of the high rental costs, the pit emptiers requested a handcart as part of the equipment. A handcart was then designed that could carry both the pump and the tank (the 200-litre oil drum). This combination made the unit rather difficult to handle. The emptiers therefore suggested separate carts for the pump and the oil drum.

Current MAPET units therefore consist of a tank cart and a pump cart. They are lighter, easier to steer and to tip than the combined cart. This is especially relevant in situations where on-site disposal of the sludge is not possible and a full tank has to be moved to a transfer station.

The first designs of the MAPET handcarts were based on this traditional pulling principle of the

mkokoteni, the traditional handcart to transport goods in Dar es Salaam. The carts were therefore equipped with long handle bars in front to allow leg space for the driver. Most emptiers, however, preferred pushing to pulling, even through sand. Emptiers finally convinced the designers that working in the unplanned areas, with its small alleys and uneven paths, the driver has to *see* the cart in front of him in order to manoeuvre adequately. The equipment designs were therefore adjusted: short handle bars at the rear and a repositioning of the centre of gravity.

Initially, used car wheels were used for the carts. As there is a great demand for used wheels in Tanzania, they are, hard to come by. A disadvantage of using car wheels for the tank cart is that they are too wide and heavy. As the width of the cart should ideally not exceed 80 centimetres the use of car wheels implies that the tank is placed above the wheels which raises the centre of gravity. The smaller diameter of the car wheels also makes it harder to push the carts over unpaved roads.

Tricycle wheels were also tried, bought from a factory in Dar es Salaam that used Chinese parts to assemble them. This enabled the tank to be fitted in between the wheels, making the cart easier to handle. These wheels were relatively sturdy in comparison to regular bicycle wheels. There are some problems with the tricycle wheels: for example, they are too light for the loaded tank cart. Especially the bearings wear out quickly. This is aggravated by the conditions of the roads in the unplanned settlements, which are often sandy. Although fat caps have been introduced, the ball bearings remain a vulnerable part. The final disadvantage of the tricycle wheels is, that the only tires fitting them, are those supplied by the same Chinese company. The quality of these tires leaves much to be desired. Despite these disadvantages tricycle wheels are still used, mainly due to the lack of an alternative option.

A reduction of the load on the wheels could also be achieved by exchanging one tank cart of 200 litres by two tank carts of 100 litres. The lower pay load could enable the application of standard bicycle wheels and tyres.

5.6 Hose-pipes and couplings

The air connection between the pump and the tank consists of a 3/4-inch water hose-pipe of the sort readily available in Tanzania. The hose-pipe that drains the sludge from the latrines has a diameter of four inches and a minimum length of 4 metres. It should be flexible enough to be manoeuvred into the squatting hole of the latrine. It turned out that the best hose-pipes for this purpose were those made of synthetic material (PE). These are available in Tanzania, but they are not locally produced and have to be imported. Locally produced rubber hose-pipes have a diameter of 3.5 inches. The quality of these pipes is not up to the standards required for the MAPET units. They are not very flexible; when bent they tend to kink rather than curve.

The hose-pipes are connected to the tanks with *Bauer* clamp-couplings. These are the standard couplings applied by DSSD for the large vacuum tankers. The couplings can be bought in Tanzania but they are not made locally. So far, MAPET has been able to use couplings that were in stock at the DSSD. During the project the possibilities for local production were looked into. It seems technically possible to have the couplings produced in Tanzania. The question remains whether demand is high enough to make production economically viable.

5.7 Maintenance

Local maintenance capabilities were built up through the participation of DSSD mechanics in all development phases of the MAPET technology. Through this participation the know-how on operating and design principles, material application, procurement of parts and their assembly have been transferred to the employees of the organization that has main responsibility for maintenance.

In practice responsibilities for maintenance have developed in such a way that a separation is made between small maintenance, taken care of by the emptiers themselves, and special maintenance which has to be performed by the supplier, being DSSD. This separation has everything to do with payment for maintenance and the availability of a vehicle to transport the equipment to the workshop for repairs.

Minor repairs can be taken care of by *Jundis* (Kiswahili for artisans) who run their private small businesses in the unplanned areas, close to the location of the MAPET equipment. These minor repairs are paid for by the MAPET emptiers out of their earnings for the day. This, however, also limits the amounts that can be spent on such repairs. Most of these repairs are spot welding of loosened parts and repair of tyre punctures. There is a common understanding that the maximum amount paid for small repairs roughly equals the income of an emptying job of 10 tank loads ($ 25).

The more specialized repairs mainly concern the handpump (bearings and guides, piston leather, valve) and the wheels (bearings, tyres). The adequate performance of these maintenance jobs is not a technological issue in terms of know-how or supplies, but a financial and organizational one primarily related to the availability of a vehicle to transport the MAPET equipment from the place of operation (breakdown) to the repair shop.

MAPET has proved that it can survive under the prevailing local maintenance conditions. The applied pump technology is such that worn out parts (bearings, guides, piston leather) lead to pumping failure before much harm is done to other parts of the equipment. For example, a worn out piston leather stops the functioning of the vacuum pump, but still protects the pump cylinder from being damaged by the metal piston parts. The bicycle wheels, on the other hand, are more vulnerable. Riding without mending a puncture ruins the tyres, riding with dry or worn out bearing balls damages the cups, leading to major repairs.

CHAPTER 6 INFORMAL MAPET BUSINESS

6.1 Character of the MAPET teams

MAPET emptiers are self-employed workers belonging to a low-income group. Each MAPET team is itself responsible for the continuity of its activities and income. Currently, each of the seven teams consists of three persons. This is the optimal number of people per team, balancing the work that needs to be done with the income needed to sustain the teams members. Each team has a leader who selects his team mates from among his friends and relatives. Some teams have a strict division of labour, with each member performing the same task(s) with each emptying. Most teams share the tasks on a rota basis.

In contrast to the traditional emptiers, most MAPET teams work on a full-time basis, being busy with either pit emptying or looking for customers. It is difficult to find the right terms for describing the economic aspects of their work. The three men work as a team and are fully dependent on each other for carrying out the work and earning money. But they do not form an economic unit or business enterprise, as the revenue of the MAPET teams' activities are shared on a daily basis and almost entirely used as personal income: there is no room for investment nor substantial savings.

Elements of the informal MAPET business are:
The equipment is not owned by the emptiers, though they are the only people working with it; instead they pay a lease fee.
The lease fee covers the costs of large repair and overhaul of the equipment.
The business is not registered.
The team and the equipment is monitored by the DSSD/MAPET staff, who act as liaison with the CCM office and DSSD, and arranges for maintenance.
The monitoring/liaison staff are paid for by a parent organization (in this case DSSD).

One MAPET team is formed by DSSD employees: the *'Kilafi'* team ('moonlighters' team, the nick name given by the private emptiers), with the senior MAPET mechanic as team leader. Especially when conventional pit emptying staff members are without work due to the breakdown of tanker vehicles, it is common practice that they carry out some MAPET jobs. Experience shows that the DSSD staffed MAPET team operates on the same informal basis as the private teams, charging fees to customers to supplement their DSSD salaries.

The Kilafi-team is an interesting option: for DSSD, as they can keep their staff occupied, and for members of staff, as they can supplement their income. DSSD staffed teams will especially deal with customer requests for pit emptying coming through the DSSD booking offices. These will primarily be requests from areas without a permanent team.

6.2 Emptying fee

From the start of the pilot project, the MAPET emptiers have been free to negotiate the price with their customers. They themselves have determined through a process of trial and error that the unit price is one tank load of sludge taken out. Over the years the price has increased with the

general rise of the cost of living. The emptiers have learned through experience that their job does not necessarily consist of emptying a pit completely, but that it can also be a matter of taking out only a little sludge. The customer decides how many tank loads of sludge will be taken out, depending on his ability to pay.

Charging a standard price per tank load helps the emptiers to calculate their price in their negotiations with customers. The drawback of this method is that it does not take account of the variation in labour required per tank load. The amount of time and labour varies with the viscosity of the sludge. Emptying a pit latrine with four tank loads may take anything between two and six hours, including preparations, digging, pumping, covering the disposal hole, and cleaning up. This time/labour variation is not expressed in the total price charged by the emptiers.

6.3 Turnover

Pit-emptying as the sole source of income relies on a steady supply of customers in an area that is small enough to be covered without motorized transport. The nett income for a team member would have to be at least the TSh equivalent of $75 per month[8]. The average charge for a tank load was the equivalent of $2.5. As the average job consists of five tank loads, a team earns $ 12.5 per customer which usually constitutes their daily income, as it is normally not possible to empty more than one latrine per day.

Although the MAPET emptiers do not seem to mind to work over the weekend, there is a limitation to the number of workable days per year, for two reasons:
- Rains prohibit emptying periodically in the rainy season;
- Around celebrations like Christmas and Ramadan customers customers spend less on pit emptying.

The following table shows the estimated equivalents of turnover and personal income in $:

	average per customer			*estimated totals per year for a team of three emptiers*			*income per team member*		
	fee $	*load #*	*total $*	*customers*	*turnover*	*costs*	*income*	*per year*	*per month*
regular customers	2.5	5	12.5	250	3,125	125	3,000		
special jobs	1.5	50	75	2	150	30	120		
total					3275	175	3,120	1,040	87

[8] *The estimated subsistence level in urban Dar es Salaam in 1992 was TSh 15,0001- per month at a rate of TSh 2001|- to the dollar.*

6.4 Loans

The earnings of the MAPET teams are too small to repay loans within a reasonable time. This had its effect, for instance, on the repayment of loans given to the MAPET teams through the project. The loans were meant to provide the MAPET teams with protective clothing (overalls, rubber boots and gloves) and a bicycle as a means of contacting customers. The loans were settled formally, with contracts and surety, and the teams had agreed beforehand that the monthly instalments were within their means.

To collect the loan repayments, however, proved to be difficult. The DSSD/MAPET staff member would have to be present at the time the customer was paying for the MAPET services, and demanding his dues before the money was used for other purposes. The MAPET staff member was seldom able to be at the right time and place to demand that repayment.

The MAPET pilot project was not in the position to continue investigating alternative ways of loan collection from the emptiers. The same problem was experienced with the collection of the lease payments from the emptiers.

CHAPTER 7 CUSTOMERS AND THE COMMUNITY

7.1 Customers' opinions

The residents of low-income areas in Dar es Salaam have definite ideas about the advantages and disadvantages of the available pit emptying services. At present, residents have complaints about both the MAPET and the DSSD tanker services, though for different reasons.

Which criteria do customers apply to assess the pit emptying services? The residents judge the effectiveness of an emptying service from several perspectives, including its organization and accessibility, its financial implications, as well as the actual services performed on their own plot. Only if a service is reasonably satisfactory, are customers willing to pay for it. To assess the residents' opinions two social surveys were conducted and meetings with leaders and other residents were held.

Throughout the project, meetings have been held with neighbourhood leaders of Party branches and Local Government wards. These meetings were necessary in order to gain permission for the MAPET emptiers to operate in the area, to make the leaders a point of reference for residents and emptiers alike, and to secure an overnight parking place in the area for the equipment. Evaluation meetings were held later to hear the leaders' opinions about the MAPET and DSSD tanker services, and their views on future operations.

7.2 Criteria for pit emptying services

The four main customers' criteria are:
- The services should be of good quality
- The costs should be reasonable and affordable
- The social accessibility (i.e. the relationship between the providers and the customers) should be satisfactory
- The physical accessibility should be reasonable

Good quality services imply first of all reliable services, that is, if the emptying is said to take place on a particular day, it should be done without fail. Secondly, waiting times should be short. People want immediate services as they only make the request for emptying when the latrine pit is already full, and the need for emptying is very urgent. And thirdly, the services should be hygienic.

The customer applies the criterion of **reasonable and affordable costs** on both the quality of the services and his own financial situation at the time of emptying. The customer wants in the first place value for money. He considers a price high when the rendered services do not meet his standard of good quality services.

Inconvenience, delays, being cheated on the amount of sludge taken out are reasons for customers for not wanting to pay more money for pit emptying services. An objective comparison of the price per volume of sludge is not the main or only consideration for a

customer.

A further consideration is, that the cost structure should fit in with the household expenditure pattern. Many households are accustomed to buying small amounts of goods, spending each time a small amount of money, while knowing full well that they spend in total a high amount. Many customers want to apply the same principle to pit emptying services, i.e. paying a small amount of money for a small amount of services.

Social accessibility is another complex criterion used by residents. People want a service agency to be personal and not bureaucratic. They want to have direct contact with the emptying crew, so they can agree directly with them on the details of the services.

Customers also want to influence and control the pit emptying work. They want to supervise the quality of the work themselves, and to have influence on the organization of pit emptying on neighbourhood level. People think that neighbourhood leaders, residents, emptiers, and the staff members of the service agency should cooperate closely. They expect that this could make the services more cost-effective, of higher quality, and of benefit to a larger number of people.

A final criterion is the **physical accessibility** of the services. Men and women, are too busy to waste time and money on bus fare to travel to the central DSSD booking office. Rather, they prefer to go to an office in their immediate neighbourhood to request emptying services.

7.3 Customers' criteria and MAPET

The MAPET services score well on most of the above criteria. The services are performed within one or two days after an agreement has been reached with the emptiers. The customer can also rely on the emptiers, as it is in their own interest to perform the service on the agreed day. The price is considered reasonable and affordable (see Paragraph 1.4). Personal negotiations with the pit emptiers is the only way of securing the services. And since the emptiers' place of contact is in the immediate neighbourhood (usually at the CCM branch office), customers spend a minimum amount of time and money on contacting them.

On two counts, however, MAPET is at a disadvantage, one being the sludge disposal method. Some customers consider it unhygienic to bury the sludge on their plot. Another disadvantage is the price per volume of sludge. Compared with the large and mini tanker services, MAPET is the most expensive per m^3 of sludge. The price for DSSD tanker services is set by the Tanzanian government and includes a large subsidy element. In contrast, the MAPET price is not imposed by DSSD, but is the outcome of negotiations between emptiers and individual customers.

The price per 200-litre drum is determined by what the emptiers consider an acceptable reward for their labour and by the negotiations between individual customers and emptiers. As such, a general price level is socially accepted with fluctuations above and below, depending on the size of the job and the social status of the customer. As discussed elsewhere in this report, this price does not cover investment costs or the costs made by DSSD to support the MAPET services.

7.4 Clean a little, pay a little

It has been baffling to hear people comment that MAPET services are 'cheap'. High government officials as well as poor people have made this remark. What do they mean when they describe MAPET as 'cheap'.

The answer lies in the (small) 200-litre drum as unit of service and in the possibility of negotiating about the number of drums to be bought (that is, the number of drums of sludge to be taken out). The drum as a unit of service fits into the buying behaviour of low-income customers, who often buy small quantities of a commodity (e.g. a cupful of sugar).

From an objective perspective, MAPET is expensive, as poor customers pay for three drums (or 600 litres) the same amount as paid for a (heavily subsidised) 5000 litres' vacuum tanker service. However, the vacuum tankers cannot operate in the unplanned areas of Dar es Salaam, making MAPET the only available pit emptying service for these areas.

To empty a full latrine pit (10 m^3) with MAPET only, may take 50 drums. Although the customer would pay a lump sum instead of the multiple unit price per drum, the total cost of the pit emptying would be extremely high. To have a few drums of sludge taken out, so as to make the latrine function again, is then a 'cheap', yet great benefit.

There is great variation in the amount of service requested, from 1 drum to 30 drums per customer. Almost half the customers request four to seven drums (800 to 1400 litres) to be taken out, while about 25% asked for one, two or three drums.

People prefer services that are flexible and negotiable. The customers' argument is twofold. The poor, who have a low income, can only afford small expenses. They will benefit greatly when they can use their latrine again after a couple of drums have been pumped out. In addition, people with low to middle incomes may be temporarily short of cash due to various commitments. They too will benefit if they can pay a small amount to receive a small service, expecting that they will later ask for further service.

7.5 Customers' demand

The customers' surveys show the wide range of prices people are willing to pay for pit emptying, TSh equivalents of $10 to $20 are not uncommon. Compared with the equivalent vacuum tanker price of $6 (in 1992), this shows the existence of a real demand for pit emptying services. Additional evidence for the existence of a demand for pit emptying, is the fact that of the seven MAPET teams operating in Dar es Salaam none has stopped working for lack of customers.

It is, however, not known for how many people the minimum price of two drums (equivalent of $5) is beyond their ability to pay. Such people do exist, as the MAPET emptiers recorded when they had charged 'social' prices at the insistence of neighbourhood leaders.

A final remark concerns the conflict of interest between MAPET emptiers and customers. The emptiers earn more from large jobs. They tend to refuse the jobs of one or two drums, which they

consider not worth their effort. The very low-income customers, who can afford to spend small amounts only, may therefore not get any service at all.

As long as the service is organized on a one customer basis, this contradiction cannot be solved. A community based organization might change this. If a number of customers in one area can be organized to have their pit emptied within, for example, the same week, the emptiers could work more efficiently than at present. Their present work style compels them to spend much time on looking for customers and walking long distances from one part of the area to the other (even within one CCM branch, which is their 'territory'). They could provide services to more people, if they could move quickly from one customer to the next. In such a set up the MAPET emptiers could earn at least the same daily amount as at present while charging less to individual customers.

7.6 A community based service

The CCM Party branch is the most important organizational unit in Dar es Salaam. The MAPET services can only reach their customers through the cooperation of the branch leaders. Once the leaders are convinced that MAPET is effective and the emptiers honourable men, they will then introduce the services and the emptiers to the residents.

An introduction and promotion procedure has been developed in close consultation with the emptiers, neighbourhood leaders, DSSD and WASTE Consultants staff members, which can be described as follows. First, a team of MAPET emptiers chooses a branch as their area of work, having assessed the effective demand for pit emptying and having established some social contacts there. Then, a member of the DSSD staff visits the branch chairman and asks him to organize a meeting with the other branch officials. At that meeting both DSSD staff members and MAPET emptiers are present. They explain about MAPET and answer any questions. Usually the leaders are interested in the new technology, which they consider a solution worth trying for a sanitation problem they all experience. The next step is, that the branch officials solicit potential customers in their area, house owners with full latrine pits, and persuade them to allow a MAPET demonstration on their plot.

On the agreed day the MAPET emptiers will give their first demonstration in the branch. The residents have been informed, and officials, neighbours and passers-by watch the whole MAPET routine, commenting on what they see. Several demonstrations are organized in this way by the branch officials, through which the MAPET services become a familiar feature in the area and the emptiers gain credibility.

Having introduced MAPET in seven branches, we conclude that the pattern of acceptance is as follows. After the demonstrations the MAPET emptiers find easily five to ten customers, which provides them with two to three weeks of work. After this initial enthusiasm, it becomes more difficult to find customers. It requires a follow-up promotion campaign to start a more regular and sustained flow of customers. Awareness raising about the health effects of overflowing pit latrines should be an important component of such a promotion campaign.

After the introduction period, the role of neighbourhood leaders in MAPET affairs is to mediate

in difficulties and represent the community to the authorities. Leaders may sometimes negotiate a low price for very poor people or they may pay on behalf of a customer, which is in fact a loan out of the branch cash box. This intervention is crucial from the point of view of public health, living conditions on individual plots, and for the MAPET emptiers whose regular income is secured. Also, branch leaders have pressurized DSSD several times to prevent the withdrawal of a MAPET team from a neighbourhood. And they continue to clamour for more MAPET equipment.

7.7 Community control

It is an operational condition that MAPET emptiers are based in a well-defined social area, the CCM branch. As informal businessmen, the emptiers depend on a social network of former customers, acquaintances and friends who can vouch for the quality of their work. For house owners too, it is important that they can contact the emptiers easily within their own neighbourhood, and can develop a kind of personal service relation with them.

There is certainly scope for a strengthening of community control over MAPET. This would entail that the leaders organize systematic and regular services within their territory. Leaders and residents have, for example, suggested to make a plan to serve all house owners in a particular street within one week, and to serve all house owners in the next street in the following week. This set up will result in lower service prices for individuals. It requires cooperation, public health awareness and self-discipline from the residents. If announced in advance, house owners can start making financial arrangements.

Another possibility suggested is that a community through its branch officials or an elected Water and Sanitation Committee owns the MAPET equipment. The Committee might then apply MAPET services directly where they are required.

7.8 Gender aspects

Theoretically, several roles can be identified for women in the MAPET services, i.e. as beneficiaries, customers, MAPET emptiers, and as managers.

Improved environmental health conditions is the most obvious benefit for women, although both men and women appreciate a clean, good looking house. As children and other household members fall less frequently ill because of improved conditions, women's work burden is reduced accordingly.

Women, as customers, have often been reported to initiate the discussion about the need for pit emptying. Ideally, people say, husband and wife decide together about the pit emptying. But as large expenditures are the husband's responsibility, (particularly if he is the main income earner) he has the final say. Married women usually earn small amounts of money in the informal sector, insufficient to pay for the pit emptying services. Booking the pit emptying services with DSSD or MAPET is done by either husband or wife. MAPET emptiers, however, are the most accessible to women, as MAPET, in contrast to DSSD, can be contacted within the neighbourhood, where women can move easily. It is the husband who negotiates with the emptiers and makes the actual

payment.

Early in the MAPET project a women's cooperative was approached as a possible contact point of the MAPET services. The cooperative, selling handicrafts and running a small restaurant, was interested in any new business venture. However, this organization lacked the required technical and coordinating capabilities as well as the necessary means of transport to act as a MAPET contact. Without substantial training and financial support the women's cooperative would have failed in this enterprise. The MAPET project did not have the means to provide the support they needed. Nor could it guarantee a profit.

Women might have become pit emptiers. Community members (men), however, considered the work too heavy for women. And, as the project staff left the recruitment of new workers to the already engaged MAPET emptiers, no women applicants came forward.

Nevertheless, the DSSD/MAPET coordinator is a woman, originally seconded by the Ministry of Water to the MAPET project. As one of the few professional women in the world of male engineers and technicians, she has gained the respect of both the pit emptiers and the DSSD management. In the next project phase - with opportunities to try out various forms of management - there will be a privately owned and managed MAPET service next to the public/private services. The first private owner is likely to be this same MAPET coordinator. She is able to manage the MAPET services as she, in contrast to the women's cooperative mentioned above, has learned the technical and organizational aspects of the work over the past five years, and besides, she possesses the private means of transport necessary for flexible coordination.

CHAPTER 8 INSTITUTIONAL SETTING

8.1 Formal - informal cooperation

The MAPET services are an extension of the traditional system, incorporated within a formal framework. They are part of the DSSD organization, in particular of the Low-Cost Sanitation Division. MAPET has also developed effective links on a neighbourhood level with the CCM party branch offices and with the City Council Health Assistants located in the (Local Government) Ward offices.

Within the framework of the MAPET project a type of formal - informal cooperation was established between the DSSD and the private, self-employed MAPET emptiers, whereby the former is the owner of the equipment and responsible for its maintenance. Selfemployed emptiers lease the equipment and earn an income by charging a fee to the customers whose latrine pit they empty.

This form of cooperation was chosen, because on the one hand the DSSD has final responsibility for pit latrine emptying services in Dar es Salaam and it is an organization set up to own and maintain pit emptying equipment. On the other hand, self-employment in pit emptying is a continuation of the traditional system. In addition, self-employment, where income depends on one's own work, ensures that maximum use is made of the equipment. This is in the interest of pit emptying and public health in low-income areas.

DSSD considered it in its own interest to develop equipment appropriate for the local situation. DSSD expected that the MAPET equipment would enable it to fulfil its public mandate to service both the unplanned and the planned areas of Dar es Salaam.

To confirm MAPET's integration in the DSSD structure, the DSSD management established a MAPET Section in the Low-Cost Sanitation Division as well as a separate account to be administered by the Finance and Administration Division. The MAPET account was fed by Dutch project funds. The transferral of expected payments of lease fees and loan instalments to the account did not materialize.

8.2 Neighbourhood offices

The political party Chama Cha Mapinduzi (CCM) is the most important organizing structure in Dar es Salaam, relating the smallest unit (the branch) to politics at city and national level. Partly parallel to the political structure, a local government structure exists that links the wards to the City Council. Politically and in the day-to-day reality of the low-income neighbourhoods, the CCM branches carry much weight in the One-Party Democracy of Tanzania.

In 1992 announcement was made that multi-party elections would soon take place; it is generally expected that CCM will then lose its dominant position in the country. It is unclear what effect this will have on the position of the CCM branch officials. It is possible that their functions of administration and control will be taken over by the Ward officials, or by specialized committees

such as Water and Sanitation Committees.

It is clear, however, that MAPET as a semi-independent service operated by informal emptiers, can only exist through institutional linkages on a neighbourhood level with representatives of the formal political/government structure. The quality of these linkages depend partly on how successful the emptiers themselves are in cultivating the social ties with the leaders and officials.

8.3 Enabling support

MAPET is an example of a decentralized service able to respond to community demands, being established in cooperation with a public service organization which provides enabling support. An enabling strategy aims at ensuring that the conditions for decentralized services are favourable and undertaking those city-wide actions which are beyond the capacity of community based organizations.

MAPET experience in Dar es Salaam shows which enabling activities are required to make it a continuing and satisfactory service:
- Creation of a suitable policy atmosphere;
- Interdepartmental cooperation;
- Training;
- Monitoring the quality of service;
- Transfer, disposal, and treatment of sludge;
- Maintenance and repair of equipment;
- Facilitating access to financial resources;
- Service promotion and health education.

Creation of a suitable policy atmosphere

The Dar es Salaam municipal bye-laws do not allow the burial of sludge on residential plots as a method of disposal. However, the DSSD management has been able to win the approval of the City authorities to carry out a pilot MAPET service which relies on exactly this disposal method. The authorities included both the City Councillors and the officials of the CCM. The Ministry of Water has strongly supported the DSSD in its lobbying efforts.

In future, however, it will become necessary to create a byelaw which is expbcit in establishing MAPET as a legitimate service for which the DSSD is responsible. This will be necessary when the MAPET services expand to cover a larger area of Dar es Salaam, and when MAPET becomes linked to a mobile sludge transfer system to be carried out by the DSSD.

Interdepartmental cooperation

The Dar es Salaam Health Department has curative, as well as preventive and public health tasks. It belongs, therefore, to the responsibilities of the health officials to motivate people to empty their latrine pits in time. The interests of the MAPET emptiers, the DSSD and the Health Department coincide in this respect.

The DSSD has taken the initiative to establish basic cooperation with the municipal Health

Department, although limited to field level cooperation. Since then, the Health Assistants working in the City ward clinics were allowed to coordinate their activities with the DSSD/MAPET staff and the MAPET emptiers. This coordination was especially effective in an area with a high groundwater level, and in another with a small outbreak of cholera.

There is ample scope to increase cooperation on ward level when in future more preventive pit emptying is carried out, and a more cost-effective organization of pit emptying is put into place.

Training

DSSD has facilitated on-the-job training for three categories of personnel, thus ensuring the continuation of MAPET. Two members of staff, one from DSSD and one seconded by the Ministry of Water, were involved in developing the MAPET technology and services together with the WASTE Consultants technician right from the start. Subsequently, they were released from their other duties in order to spend time on the management of MAPET.

DSSD also made three mechanics available to work on the construction of equipment thereby ensuring transfer of technical knowledge. The mechanics learned *inter alia* the identification of problems and solutions, how to order components, and how to assemble the equipment. This enabled the mechanics to carry out maintenance and repair jobs independently.

The final category of trainees are the MAPET emptiers. They are trained by the DSSD/- MAPET staff in the operation of the equipment, hygienic aspects, and technical knowledge. The DSSD only allows properly trained emptiers to form a team and provide MAPET services independently.

The transfer of knowledge has been continued as DSSD/MAPET staff, mechanics and emptiers have provided training to their counterparts in the Municipality of Morogoro. DSSD has been established as the source of knowledge and experience and will also in future be responsible for the dissemination of this knowledge *to* other organizations (municipalities, NGOs, or private entrepreneurs), which intend to establish MAPET services.

Monitoring the quality of service

DSSD as a public organization remains responsible for the quality of service irrespective of the fact whether the service is carried out by DSSD itself or by others. Monitoring the quality of service is, therefore, interlinked with proper training.

The DSSD/MAPET staff has been engaged in monitoring the MAPET teams, concentrating on things such as the proper handling of the equipment, safe and hygienic performance, proper burying and disposal practices, and the prices charged.

Monitoring however assumes that the staff can be present at the site when the actual emptying takes place. This often has been difficult to realize as staff members do not have the same mobility as the emptiers.

Disposal, transfer and treatment of sludge

Three modalities regarding the final handling of sludge are feasible, i.e. burying on the

customer's plot, disposal at a neighbourhood facility followed by treatment, and transfer to a central sewage treatment facility operated by the City Council where the sludge is also treated. The largest enabling responsibility for DSSD lies with the third modality, which implies the haulage of sludge over a long distance to the central treatment plant. By operating such a transfer system with its own vacuum tankers, DSSD can facilitate the expansion of MAPET's public health service to new residential areas.

Maintenance and repair of equipment
It will be DSSD's enabling role to carry out major repairs on the pit emptying equipment. Some experience has already been gained with the type of repairs that small, informal sector workshops can carry out, the spare parts they can obtain in the local market, and the price level the emptiers can afford to pay. A sensitive information system will alert DSSD to the problems and possibilities of the emptiers and the local workshops in these respects.

Facilitating access to financial resources
The MAPET emptiers depend on an intermediate organization for access to financial resources. Their income level does not allow purchase of the MAPET equipment. Their informal status restricts access to formal loan institutions. DSSD has acted as such an intermediate organization by utilizing MAPET project funds. Several forms of support are used. First, the MAPET equipment is leased to the pit emptiers, for which they pay a nominal fee. Secondly, the cost of major repairs is borne by DSSD (ideally these costs should be covered from the lease fee), while the emptiers only pay for minor repairs out of their own pocket. And finally, the emptiers are given a loan for the purchase of such necessary items as protective clothing and a bicycle for communicating with customers and the *DSSD* office.

The continuation of this system of financial support depends on external financial investments and regular payment of fees and reimbursements by the emptiers. This requires an institutional structure that is able to deal with highly mobile pit emptiers whose daily income is quickly spent.

MAPET promotion and public health education
A MAPET promotion campaign (comparable to project support communication) is essential to establish the service in a new area. After the initial campaign, the DSSD/MAPET staff should also be available to facilitate communication and solve incidental misunderstandings between MAPET emptiers, residents, municipal employees and others.

An important component of the promotion campaign is public health education. Awareness about the health aspects of the operation and emptying of pit latrines is one of the means of motivating people to take action about their full latrine pit.

CHAPTER 9 MAPET AS PART OF URBAN SANITATION

9.1 Sludge treatment

MAPET is rooted in the traditional practice to bury latrine sludge on-site on the customers plot. A shallow hole is dug into which the latrine sludge is to be deposited. The sludge is pumped out of the latrine pit by creating a vacuum in the MAPET tank. When the tank is full, the sludge is discharged into the hole. The process of filling up the tank and discharging the sludge, is repeated as often as required. After one or two days the sludge in the hole can be covered with the excavated soil. The MAPET emptiers have been trained to cover the sludge with a layer of dry soil of at least one foot.

In Dar es Salaam the population accepts the burying of sludge, even close to their living quarters, provided the process of emptying and burying is performed hygienically and the sludge if fully out of sight (covered properly). Traditionally there is strong resistance to using the sludge as a manure, even after it has decomposed for several years. This probably is the best guarantee that the buried sludge will not be dug up before decomposition.

The practice of burying does neither improve nor aggravate the problem of groundwater contamination. This problem is caused by the existence of latrine pits (of a depth of 12 feet) rather than by the shallow holes (of 4 to 5 feet) that are dug for sludge burying.

There are two situations when sludge cannot be buried:

1. *When there is not sufficient space to dig a hole.*
   This situation exists, for example, in the area of Keko, a very densely populated area, with steep slopes, near the city centre.
2. *When there is a high groundwater table.* This condition exists permanently in the low parts of unplanned areas, in some waterlogged areas, and seasonably in most areas during the long rains. The soil then has no leaching capacity. In that situation the burying of sludge should not take place so as to avoid upflow and soiling of the surface with fresh sludge.

Both constraints necessitate another routine of sludge removal: to haul sludge by means of the tank carts to a transfer station where it can be temporarily disposed of, or waiting for long distance hauling to a final treatment facility (in the case of Dar es Salaam: one of the sewage treatment ponds).

9.2 Sludge transfer

9.2.1 Fixed transfer stations

The alternative to burying sludge on-site was sought in the use of transfer stations: large concrete tanks with a capacity of 10,000 litres. They were to be located close enough to the latrines so that MAPET emptiers could transport the sludge to them (maximum of 0.5 to 1 km walking distance). They also had to be accessible to the large vacuum tankers that would regularly take the sludge from the transfer stations to the sewage ponds. Two such transfer stations have been built during

the project. As had been expected neither has been used, though for different reasons.

Building the first transfer station in Manzese exposed the difficulties that exist in Dar es Salaam with respect to urban planning. The ideal places for transfer stations happen to be in areas where the demand for land is high. Land cannot be bought in Dar es Salaam but can be obtained only by long-term lease. Securing a lease, especially for a plot that is in demand, involves formal and informal negotiations, political manoeuvring, payments and competition with other claimants. With the help of one City Councillor a site was allocated to DSSD where it could build a transfer station. However, another claimant had an even more powerful supporter, so that in the end DSSD was forced to abandon the site.

The second transfer station was therefore built on DSSD land, near the DSSD main office in Mwananyamala. It made it possible to avoid all the hassle with planning permissions. The problem with this transfer station was its poor accessibility for the MAPET team. It was located in an area were there was only a seasonal need to use the transfer station. During the wet season, however, the sandy roads became very muddy and thus almost impassable for a loaded MAPET tank cart.

Moreover, a system with so-called fixed transfer stations necessitates a large number of stations (a few hundred at a grid of 1 - 2 km distance). This is a capital intensive infrastructure which in many areas would only be used during a short period of the year. The experiences led to the conclusion that, given the obscure planning procedures and the high capital investment required, it would not be appropriate to attempt to realise a network of fixed transfer stations in Dar es Salaam. This led to the idea of developing a mobile transfer station,

9.2.2 Mobile sludge transfer system

A preliminary study has been done into the possibilities of using a mobile sludge transfer station (MSTS), which can travel with the emptying teams if needed, and which is not hampered by planning procedures, e.g. a tank trailer that is pulled by a tractor. The MSTS tank volume can be less than a fixed transfer station (2 m^3 in stead of 10), which is sufficient to cater for two average daily MAPET jobs. The MSTS tank can discharge daily in the treatment ponds and, like the tankers, be guarded overnight in a central depot.

MSTS tanks can be used in more than one area. An effective and efficient use of the MSTS system will require some fine tuning of communications between DSSD and the MAPET emptiers. The MAPET teams will have to be able to indicate where and when the MSTS tanks are needed, and the DSSD has to be able to schedule the routing of the tanks. How these communications can be organized is one of the matters that still have to be established during field tests with the system.

9.3 Linkages

The linkages of MAPET with other elements of the sanitation system are shown in the following diagram. A distinction is made between sludge emptying, sludge transfer, and sludge treatment. With on-site sludge disposal, the MAPET service is a completely independent operation. When

off-site disposal entails the burying of sludge on a neighbourhood site (one team has hired an empty piece of land for this purpose), the tank cart will haul the sludge over a distance of not more than 1 km. Full off-site treatment, involves sludge hauling over a longer distance by making use of transfer stations and vacuum tankers or MSTS. These will discharge the sludge into the sewage treatment ponds which are part of the piped sewerage infrastructure.

Given the increasing density of the population and the reduction of open space, it is to be expected that the need to operationalize a system for long haul and off-site treatment of latrine sludge will acquire great urgency in the near future.

sanitation service	*sludge emptying*	*sludge transfer*			*sludge treatment*
		short haul	*temporary disposal*	*long haul*	
MAPET on-site disposal	vacuum pump and tank cart	burying at customer's site			
MAPET offsite disposal	vacuum pump and tank cart	tank cart	burying at neighbourhood site		
MAPET with sludge transfer	vacuum pump and tank cart	tank cart	transfer station	vacuum tanker or MSTS	sewage treatment ponds
vacuum tankers		vacuum tanker		sewage treatment ponds	
piped sewerage		sewer infrastructure		sewage treatment ponds	

9.4 Financing structure

9.4.1 Government services

Public services usually are financed out of the government budget in combination with nominal charges for the service. The government budget generally finances the establishment of the institutional and physical infrastructure to provide the services, while servicerelated fees finance the recurrent operational costs. Often the government also subsidizes the operation of the public services in order to make the service fees affordable to the public.

In the case of Dar es Salaam the institutional and physical infrastructure for sanitation (vacuum tankers as well as sewerage) is supplied through the government by donor aid. A basic government subsidy of operational costs exists in the form of staff salaries: every DSSD staff member is in one way or another on the government pay-roll. The official Tanzania government salaries and allowances, however, are lower than the subsistence level in Dar es Salaam. Salary supplementation is therefore essential for every employee. This can be done in an *official* and an *unofficial* way. The official way is, that supplementary emoluments are paid by the employer, out of the service revenue. The unofficial way is that working time and facilities (transport, equipment) are used for private income generation.

9.4.2 MAPET

Just as the sewerage system and the vacuum tankers, the MAPET assets have been financed by

donor aid. The level of investment, however, is much lower since MAPET is low-cost equipment manufactured in Tanzania. Contrary to the sewerage and vacuum tanker services, the labour costs of MAPET (i.e. the income of the self-employed emptiers) are not subsidized and covered fully out of the fees charged to the customers. As such, MAPET is only relying on public finance, or donor aid, in respect of enabling support to the establishment of services.

In Dar es Salaam it is the population of planned areas, mainly middle and high income, that benefit from donor aided capital investment and government subsidy of the vacuum tanker services and the sewer system. In contrast, the population of the unplanned areas, of which an estimated 70% is low-income, pay their share of national taxes, but receive very little in terms of services. The government operated tanker services cover only a small portion of the unplanned areas. The residents of unplanned areas are forced to turn to solutions like MAPET, which are more self-supporting but consequently more expensive.

Extent of MAPET application

Dar es Salaam consists of some 200 CCM branches, of which over 100 are located in unplanned areas. A MAPET team can service two or three branches. A reliable service would require about 50 MAPET teams, taking into consideration that MAPET is to be deployed only in the unplanned areas, inaccessible to tankers. Considering the problems of keeping the vacuum tankers operational, it is not inconceivable that MAPET teams also work in the more accessible areas.

The project has made clear that, with the support of the DSSD, MAPET teams can function on a commercial basis in some areas of Dar es Salaam. There are areas in Dar es Salaam, however, were there just are not enough customers who can afford to have their latrines emptied against the prices charged for pit emptying by either the traditional emptiers or the MAPET teams. The need for pit emptying still remains the same however. Two possible solutions for this are recommended.

First, rather than MAPET teams that work on a commercial basis, MAPET will have to be provided as a form of community service in the context of a neighbourhood improvement programme. One NGO has expressed its interest in incorporating MAPET in its community programme in two CCM branch areas, Buguruni and Vigunguti.

Another possible solution could be to combine pit emptying with another form of public services, such as the collection of solid waste. Both services will be charged for. A shortcoming of this solution could be that traditionally, unlike the emptying of pit latrines, the collection of solid waste is not a service for which a payment is charged.

CHAPTER 10 SUSTAINABILITY

10.1 Achievements to be sustained

MAPET started as a pilot project for technology development only. Through its participatory approach while field testing the equipment, the project team was confronted with demands from the pit emptiers, the general public and politicians to enable the MAPET emptiers to operate their services on a regular basis. Going beyond the project's short term objectives, the team has addressed the financial aspects of a privately operated MAPET service, promotion in neighbourhood communities, technical and operational aspects of sludge transfer stations, and the exercise of public health control by the Dar es Salaam Sewerage and Sanitation Department. All this was to take place within the context of informal-formal (or private-public) cooperation. The issues identified during the MAPET project must be elaborated on in a follow-up project.

The project has contributed to the improvement of environmental sanitation by facilitating a pit emptying service in those areas where the conventional vacuum tankers cannot provide adequate services. The demand, expressed in the presence of customers who are able and ready to pay, is so high in those areas that it is worthwhile for the MAPET emptiers to define exclusive 'service territories'. MAPET's value as a reliable and affordable service for low-income groups has been recognized among other by the Health Assistants of the City Council Health Department. They regularly request the emptying service to relieve unsanitary conditions for particular customers.

The project has improved the traditional emptying method by the development of equipment that makes pit emptying a more efficient and more hygienic occupation. The pit emptiers who have decided to take up this occupation, consider working with MAPET equipment to be less dangerous and strenuous than the traditional method. At present seven teams are working in Dar es Salaam earning a modest but steady income.

10.2 Sustainability conditions

Sustainability refers to the long-term continuation of the beneficial effects. In the MAPET project, the sustainability of its achievements depend on four basic conditions:
the equipment has to be kept operational;
public hygiene standards have to be upheld;
there has to be an efficient scheduling of customers;
costs of MAPET services have to be recovered.

Each of these conditions in turn depends on several other factors which shall be discussed in more detail.

Keeping equipment operational
The linchpin of the entire service is the MAPET equipment. To keep this equipment in working order requires **supply of spare parts; maintenance; mechanics** who are sufficiently **trained** to construct and maintain the equipment; **transport** of equipment.

On the whole maintenance and minor repairs are handled by or paid for by the MAPET teams

themselves. For larger repairs they need DSSD mechanics, who are well trained for this purpose, and know how to obtain spares. The major constraint here, however, is transport of the equipment. When broken down equipment has to be taken to DSSD for repairs, a pick-up truck is needed which availability is scarce and fuel expensive.

It is the economic situation which creates a need for almost everybody in the government to work on the side, thereby reducing the efficiency of the institutions. An organization like DSSD is compelled to keep strict control over its personnel, thus limiting the use of official resources like transport.

Public hygiene standards
Proper hygiene standards are particularly relevant to sludge disposal. To make sure standards are adhered to, requires **training** of MAPET emptiers, **transfer stations** in areas with a high groundwater table, **supervision** by DSSD and a **legal framework** to give DSSD the means to enforce hygiene standards.

The involvement of DSSD in training and supervision of MAPET emptiers ensures that disposal of sludge is carried out safely and basic hygiene standards are adhered to, even though there is, as yet, no legal framework. Implementation of MAPET on a larger scale in Dar es Salaam will necessitate pit emptying in areas with a high groundwater table, where only off-site sludge disposal is possible. This will require a solution to the technical, planning and financial problems regarding the use of transfer stations. It will also require that a mobile system of monitoring and supervision be established.

Efficient scheduling of customers
To ensure that latrines are emptied before they overflow and become a public health hazard, and to give the MAPET teams enough employment requires efficient scheduling of customers. This in turn depends on factors as **promotion** of MAPET, **health education** and **community mobilisation.**

Experience with MAPET indicates that the close relationship between MAPET teams and their customers and the involvement of community leaders ensure that this condition can be met. In the long run it requires enabling support for hygiene education and community mobilization to guarantee a continuous community based activity.

Cost recovery
The final aspect relevant to sustainability is cost recovery. Recovery of labour costs relies on **efficient scheduling of customers.** To recover costs of equipment, a reliable system of **revenue collection by the owner** of the equipment should be in existence. The owner in the case of Dar es Salaam is DSSD.

Currently labour costs of MAPET teams are fully recovered. Cost recovery regarding equipment is still not feasible. DSSD does not have the means to set up an efficient system of revenue collection for the lease of equipment. On the side of the informal emptiers saving is not a common practice, resulting in a cash shortage as soon as larger repairs have to be paid for.

ANNEXES

ANNEX 1 LIST OF PROJECT RELATED DOCUMENTS

MAPET project documents

Manual Pit Emptying Technology Project, Dar es Salaam, Tanzania
Inception report
WASTE Consultants, October 1988.

Project progress April - July 1998
Progress report 1
WASTE Consultants, July 1988.

Mission report of the first MAPET mission to Dar es Salaam, Tanzania, 12 September - 4 October 1988
Progress report 2
WASTE Consultants, October 1988.

Proceedings of the round table meeting on manual pit emptying, Gouda, 7 - 9 December 1988
Progress report 3
WASTE Consultants, December 1988.

Debriefing documents to the Tanzanian partners in the MAPET project, relating to the field test mission to Dar es Salaam, February - June 1989
Progress report 4
WASTE Consultants, July 1989.

Evaluation of the MAPET field test mission in Dar es Salaam, Tanzania, February - June 1989
Progress report 5
WASTE Consultants, August 1989.

Social study of pit latrine emptying in Dar es Salaam, Tanzania, February - June 1989
Progress report 6
WASTE Consultants, September 1989.

State of the art, Manual Pit Latrine Emptying Technology Project.
WASTE Consultants, October 1989.

Mission report of the fourth mission to Dar es Salaam, February I March 1990
Progress report 7
WASTE Consultants, April 1990.

State of the art, Manual Pit Latrine Emptying Technology Project.
WASTE Consultants, April 1990.
Debriefing documents of the fifth mission to the MAPET project in Dar es Salaam, Tanzania, May/June 1990

Progress report 8
WASTE Consultants, July 1990.

The full integration of the MAPET services into the framework of the Dar es Salaam Sewerage and Sanitation Department (DSSD)
Progress report 9
WASTE Consultants, July 1991.

Technology development by WASTE Consultants

The development of an appropriate sludge pump for emptying on-site excreta disposal systems in Dar es Salaam (Tanzania).
WASTE Consultants/Technical University Delft, March 1987.

Redesign of the manually operated portable pump cart for the MAPET Project.
WASTE Consultants/ECOTEC Resource BV, January 1989.

Ontwerpen van een ergonomische handkar t.b.v. het MAPET project in Dar es Salaam, Tanzania (Designs of an ergonomic hand cart for the MAPET project in Dar es Salaam, Tanzania).
WASTE Consultants/Hogeschool Gelderland, May 1991.

Design of a Mobile Transfer Station for sludge.
WASTE Consultants/Technical University Delft, November 1991.

Documentatie en controle berekeningen van de apparatuur gebruikt in het MAPET project, Dar es Salaam, Tanzania (Documentation and engineering of the equipment in use in the MAPET project, Dar es Salaam, Tanzania).
WASTE Consultants/Hogeschool Haarlem, May 1992.

Ergonomische aspecten van de MAPET apparatuur gebruikt in Dar es Salaam, Tanzania (Ergonomic aspects of the MAPET equipment in use in Dar es Salaam, Tanzania).
WASTE Consultants/Haagse Hogeschool, September 1992.

Revised pump cart design with pipe frame, wheel forks and clamped cylinder.
WASTE Consultants, November 1992.

ANNEX 2 PROJECT CONTRIBUTORS

The project was executed by a project team of the Tanzanian staff and WASTE Consultants, in which through the years the following people participated:

Jasper Kirango (Head ofDept, DSSD)
- Pit emptying and sludge transfer system development
- Institutional development
- Local project coordination and administration

Xavier Haule and Lumesa (Mechanics, DSSD)
- Technology development, construction and maintenance
- Training

Emanuel Mwambepo (MAPET Coordinator, DSSD)
- Technology development and field testing
- Training, support and monitoring informal pit emptying
- Promotion

Yahaya Maftaha and Hamisi Athumani (traditional pit emptiers)
- Field testing technology and emptying routines
- Training of new emptiers

Emelda MwaJdJuna (MAPET Coordinator, WASTE Consultants)
- Field data collection
- Field testing of technology and service
- Training, support and monitoring MAPET teams
- Promotion

Jan van Uden (Technician, WASTE Consultants)
- Prototype and local technology development
- Development of local construction and assembly
- Technology transfer and training
- Informal business development
- Promotion

Jaap Rijnsburger (Physical planner, WASTE Consultants)
- Technology design
- Pit emptying and sludge transfer system development
- Institutional development
- Project management and administration

Maria Muller (Sociologist, WASTE Consultants)
- Household and neighbourhood surveys

– Institutional development
– Education and training
– Process monitoring and evaluation

Agnes Sikkers (Project Assistant, WASTE Consultants)
– Field data collection
– Promotion
– Local project administration

Heleen Claringbould (Sociologist, WASTE Consultants)
– Identification of community involvement
– Household and pit emptiers survey

Edward Mouw (Industrial Designer, WASTE Consultants)
– Identification of sludge transfer
– Mobile transfer station prototype design

Robert Kragting (Industrial Designer, WASTE Consultants)
– Initial identification of traditional emptying and vacuum tanker operation
– Handpump technology concept

Krijn Oosterhoff (Technician, WASTE Consultants)
– Initial prototype construction and testing

In the initial prototype development stage WASTE was assisted by several companies in the Netherlands:

Domat, Monster
– Design and construction of a 1000 1 tank trailer

Jansen Venneboer, Wijhe
– Adaptation of Volanta flywheel mechanism

Leenstra, Drachten
– Design and construction of prototype diaphragm pump

SWN, Nunspeet
– Tests with piston pump drives