MAPET: An appropriate latrine-emptying technology

by Maria S. Muller and Jaap Rijnsburger

It is clear that it will never be possible for everyone living in the cities of the South, especially in the rapidly growing mega-cities, to be connected to conventional water and sewerage mains. This technology allows homeowners to have hygienic and convenient on-site sanitation.

IN MOST CITIES in Africa a large section of the population relies on on-site sanitation. That is certainly the case in Dar es Salaam, the largest city in Tanzania, where 80 per cent of the housing units have a pit latrine. When a latrine pit in the city is full, there is rarely enough space available to build a new one, so the pit must be emptied and re-used. When pits are allowed to overflow, they are not only an unpleasant mess for the neighbourhood, they are also a threat to public health. A number of diseases, from diarrhoea to cholera, are common in areas with inadequate sanitation services.

In Dar es Salaam two systems are used to empty latrine pits. First, there is the traditional method of scooping the sludge out of the latrine pit manually using a bucket, and disposing of it in a hole that is dug elsewhere on the resident's plot. It is a time-consuming, unhygienic, and expensive method. Secondly, the Dar es Salaam Sewerage and Sanitation Department operates a pit-emptying service, which uses large vacuum tankers. These conventional tankers, however, often cannot get close enough to the latrine pits because of the limited space between houses in the unplanned or squatter areas. Dependence on imported fuel and spare parts also makes it difficult to operate a cost-effective service with these tankers. For these and other reasons the existing services could not cope with the demand for pit emptying, so a new system was developed, called the Manual Pit Latrine Emptying Technology, or MAPET. MAPET retains the positive features of each of the existing systems, combining new and old to make a more appropriate technology.


The MAPET is designed for easy handling.

Like the traditional method, MAPET uses only manual labour, both to empty the pit and to transport the equipment. It also relies on the knowledge and experience of traditional pit emptiers, because the sludge is disposed of by burying it on the resident's plot. The essential elements of the new technology are the experienced emptiers' knowledge; both of how to deal with sludges of various qualities by stirring and liquefying, and how to estimate the size of the hole to be dug for sludge disposal. The practice of independent workers who earn income by emptying pit latrines has also been retained, modified, and supported.

Recent innovations have contributed to both technology and methodology. The MAPET system uses modern handpumps and vacuum techniques, while the requirement of public health supervision by a government agency (in this case the Dar es Salaam Sewerage and Sanitation Department, DSSD) is the result of modern urban infrastructure.

The technology

The MAPET equipment consists of two main components: a piston pump with flywheel, and a 200-litre vacuum tank, each mounted on a pushcart. The pump and vacuum tank are connected together with a 3/4-inch air hose. A 4-inch hose-pipe — at least 4 metres long — is clamped to the tank to drain the sludge from the pit.

The MAPET has several attachments which are derived from traditional emptying practice: a mixing rod for stirring the sludge to improve its viscosity, a hook for removing cloth and other solid materials that block the flow of the sludge, and a spade and a hoe for digging the hole for sludge disposal. A chisel and a hammer are useful for widening the squatting hole or for making a hole in the latrine wall for the sludge hose-pipe.

An important feature of the MAPET equipment is that it is all built in Tanzania, and is based on parts, materials, and techniques readily available in small workshops. The total cost of the equipment is $US3000 (in Tanzania in 1992).

At the start of the project, two prototype handpumps were built in Tanzania, a diaphragm pump and a piston pump. Field-testing showed that the diaphragm pump was less suitable for the local conditions than the piston pump, because of the vulnerability of the rubber diaphragm. Even heavy-duty diaphragms began to crack and leak after a few months, mainly because of the sun and the tension in the rubber resulting from the required large stroke.

A piston pump with a leather piston in a 6-inch PVC cylinder made from sewage piping is now the standard MAPET pump used in Dar es Salaam.

In order to ensure that the knowledge and skills to sustain the technology were available locally, all the construction and adaptations, and all the equipment assembly have been done in Dar es Salaam by three DSSD mechanics supervised by DSSD management. As a result, the DSSD is fully able to build and maintain MAPET equipment.

Vacuum tank The first MAPET units were equipped with a 200-litre oil drum as a sludge tank. This drum was too prone to corrosion, however, and was quick to implode under vacuum-pressure.

Now the standard vacuum tank is a 200-litre tank welded out of 3mm sheet metal. It has been carefully designed to get the best performance in transport, steering, and tipping. The current design is known as the *kibuyu*, (Swahili for gourd), reflecting the shape of the tank.

An advantage of the *kibuyu* tank, as acknowledged by the pit emptiers, is that its dimensions have a lower centre of gravity, resulting in easier handling of the push cart on which it is mounted. Its better diameter:length ratio also allows the expensive sheet metal to be cut more efficiently.

Handcart and wheels Different methods of transporting the MAPET equipment were also tested. First, the MAPET pump and tank were transported on the type of hired handcart that is used locally to transport heavy loads (*mkokoteni*). Later, separate carts for the pump and the tank were developed.

The wheels of the first carts were the same as those of the *mkokoteni*: used car wheels. Car wheels, however, are expensive, heavy, and wide. This meant that the tank had to be mounted over the wheels, as locating it between the wheels would have resulted in a width larger than 800mm (see design criteria box). Using imported Chinese tricycle wheels, however, meant that the tank could be between the wheels, resulting in satisfactory loading, discharging, and moving characteristics.

The tricycle wheels also had disadvantages, as the irregular-sized tyres are vulnerable and the ball bearings are too light for a loaded tank cart. Because of the lack of alternatives, the

Design criteria	*Solutions*
Reduce dependence on imported fossil fuel.	Use human-powered equipment: ● handpump for emptying ● pushcart for transport
Prevent sludge from entering the pump to reduce both the risk of blockages and heavy wear.	Pump indirectly, creating a vacuum in the tank which will draw up the sludge. Install a gauge (a glass panel) to control the sludge level.
Make optimal use of human power for a pumping head of 3m.	Use (approximate) dimensions of: ● flywheel diameter: 800mm ● rotation speed: 40-60rpm ● pump volume per stroke: 2.0 litres ● mass of flywheel: 25kg
Must be narrow enough to negotiate small paths and gates to inner courts.	Equipment must have maximum width of 800mm (relates to the wheelbase of the carts and to the flywheel diameter).
Build and maintain units locally.	Apply locally available technologies for: ● drinking-water handpumps and piped water supplies ● motor-vehicle maintenance ● bicycle maintenance
Must not use expensive, vulnerable gate valves to make local maintenance possible.	Design the tank to be tipped: coupling position 'up' for pumping and manoeuvring, 'down' for discharge.
Ensure compatibility with DSSD tanker hose-pipes.	Use 4-inch Bauer hose-pipe couplings.
Avoid demolition of squatting slab and superstructure, which is necessary with traditional emptying.	Excavate the sludge through the squatting hole by means of a hose-pipe.

Design criteria for the development of MAPET equipment.

The use of tricycle wheels means the MAPET can be pushed down narrow alleys.

tricycle wheels are still being used, but grease caps have been introduced to protect the bearings from the omnipotent sand.

In the next project phase the tank load will be adjusted to suit the available wheels. A reduced tank size of 100 litres is expected to enable the use of standard bicycle wheels and tyres and still retain the maximum desired width of 800mm.

Sophisticated machinery and techniques are not required for either the construction or the repair of MAPET equipment; common workshop tools are sufficient. Now minor repairs are carried out by *fundis*, artisans who run their own small workshops. Their main jobs are spot-welding loosened parts and repairing tyre punctures. Major, expensive repairs are carried out in the DSSD workshop, and usually involve the handpump (bearings and guides, piston leather, or valves) and the wheels (bearings or tyres).

Disposal and treatment

The MAPET system disposes of sludge by burying it on the customer's plot. This method is safe as long as two conditions are met: there should be a layer of earth at least two feet deep on top of the sludge, and groundwater should be prevented from entering the hole and pushing the sludge up.

This disposal method assumes that there is sufficient space on the plot. Where this is not the case, as in densely built-up neighbourhoods, the sludge must be transferred to another site for disposal and treatment. The site must not have a high groundwater table and must be protected during the long rains.

In Dar es Salaam the MAPET service is based on semi-formal co-operation between the municipal DSSD and the private, self-employed MAPET emptiers working in the informal sector. The DSSD is the owner of the equipment and is responsible for maintenance. The pit emptiers lease the equipment and charge their customers directly.

Traditional pit emptiers are selected by the DSSD to become MAPET team leaders, then each team leader selects two more people to form a team with him. All the team members are trained by the DSSD to operate the equipment, carry out small repairs, and perform the emptying service in a hygienic manner.

As the agency responsible for sanitation services, the DSSD supervises the service performance of the pit emptiers.

A MAPET team empties, on average, one latrine per day, removing $1m^3$ of sludge (five tank loads). The time spent on this varies considerably, and depends on the soil conditions and the heaviness of the sludge.

The features of the MAPET equipment — its small size, manual operations, and maintenance that is carried out to a large extent by small workshops — make it suitable for use in a community-based pit-emptying service. The self-employed pit emptiers can choose their own 'service territory' or neighbourhoods, and can negotiate with their customers on how much sludge is to be removed and at what price. Requesting the service becomes easy for residents, as the pit emptiers can be contacted in the neighbourhood. In the next project phase the organization of a community service will be developed.

Integrated management

MAPET equipment provides a useful pit-emptying service in particular circumstances: when the groundwater table is low, when there is sufficient space for sludge burial, and when the location of the latrine is inaccessible for the regular tanker services. If there is equal accessibility for both the conventional tanker services and MAPET, it is more efficient to use the vacuum tankers of 2000 or 5000 litres.

The applicability of MAPET could be increased if a method of sludge disposal was developed which did not rely on on-site burial. The hauling distance of MAPET is limited to about 1km, as it is pushed manually. Its hauling capacity could be improved by introducing neighbourhood sludge-transfer stations, from where sludge is hauled to a central treatment facility, for example by conventional tanker.

The introduction of sludge transfer by means of fixed, concrete tanks has not been successful in Dar es Salaam, because of complex land-use procedures. In the proposed next project phase the application of a mobile transfer tank will be tried out. ●

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As most cities experience similar problems with on-site sanitation, one expects that small equipment similar to MAPET has been developed in other cities. The authors of this article would like to exchange information on the operation of such equipment, the organization of pit-emptying services, and the method of sludge disposal.

Subscription rates for 1995

The individual subscription rates for *Waterlines* for 1995 will stay the same: £15 ($28), but the rate for organizations or institutions will go up slightly to £20. The US$ price for organizations stays the same: $37. These changes will take effect from 1 January 1995. You can avoid this increase by paying your subscription before the New Year, and readers who pay for two years will be able to pay for both years at the old price.

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