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Evaluation of novel pit-latrine exhauster with improved access for low-income settlements

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INTRODUCTION

The problems of sanitation faced by the urban poor in many cities throughout the developing world are all too apparent with the disease profile of many slum dwellers showing a high incidence of waste-related disease. For many, the only option, governed by their ability to pay, is the basic unimproved pit latrine. Although this is obviously a better option than open defecation, their are many problems with its use in low-income areas where they cannot be adequately maintained due to lack of pit emptying facilities. Many studies have been undertaken which have highlighted the need for an appropriate technology which can be implemented as a micro-enterprise within the communities, thus relieving the burden of city authorities to provide a service which they cannot afford. UNCHS(Habitat) have recently implemented a project together with partner Manus Coffey Associates to develop and field-test a new approach to the problem.. The Kenya Water for Health Organisation (KWAHO) implemented the trials with The International Water and Sanitation Centre (IRC) being invited to monitor the social-economic feasibility. This paper reports the interim results for the project which is currently on-going in a low income area of Nairobi.

BACKGROUND

The criteria for development of the technology were as follows:

1. The service must be: affordable by the urban poor; the capital cost must be affordable by entrepreneurs who could potentially develop a micro-enterprise and; the operational costs must be recovered from revenue generated.

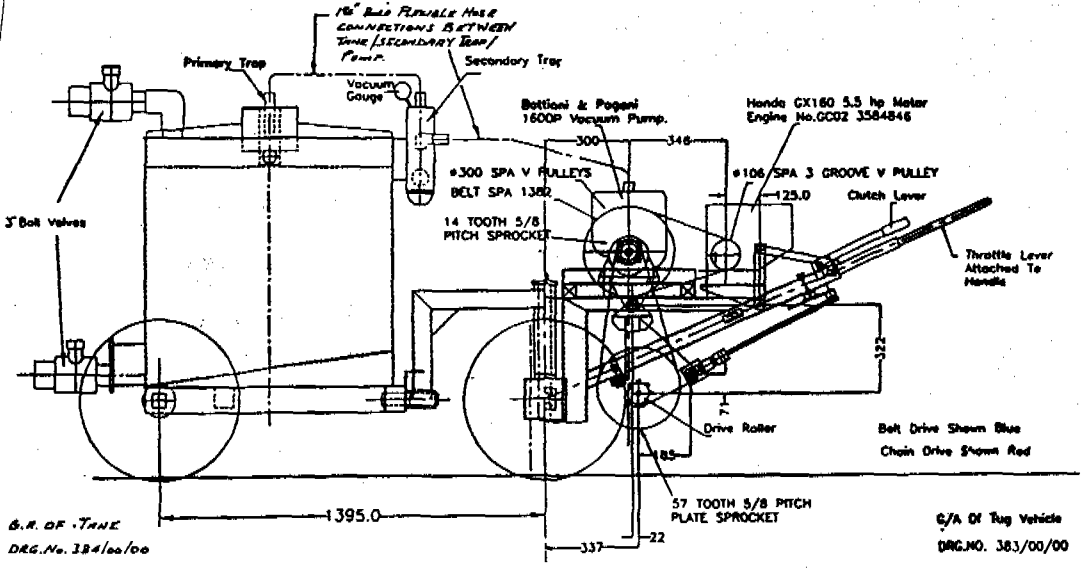
2. It must be able capable of access to some of the most dense urban areas where conventional systems are unable to penetrate.

3. It must be capable of being constructed, operated and maintained using local materials and skills.

4. The technology should be capable of transporting wastes to an appropriate disposal point and provide sufficient vacuum to enable pumping of dense consolidated sludge.

The technology that was developed comprised an articulated vacuum tank and pump/tug assembly (Figure 1). The vacuum tank is fabricated from mild steel with a nominal volume of 500 L (equivalent to 1 load). The tank is fitted with a check valve, a sight glass and two 75 mm ports, for sludge inlet and vacuum pump connection. The assembly is mounted on a steel frame fitted with second-hand car wheels and hubs. The tug assembly comprises a small frame-mounted 4.1kW petrol engine with a belt drive to connect it to either a sliding vane vacuum pump or a friction roller to drive the vehicle. In traction mode, the engine can propel the vehicle at speeds of up to 5 kph. When connected to the vacuum pump it is capable of exhausting at 1,700 L minute. The pump can be reversed to pressurize the tank to assist the discharge of sludge to the sewer or raise it to discharge into a transfer tank. The engine is mounted on a hinged plate with a rod linkage to apply tension to the belt drive. The vehicle is fitted with a motorcycle throttle and braking system. A turnable drawbar is used for towing. The unit is equipped with 4 m of 3" diameter PVC hose connected to the tank with aluminium quick-release couplings. The area selected for the trial was Kibera, the largest low-income urban area in Nairobi, Kenya which covers an area of 225 hectares and accommodates an estimated 470,000 people. Its

Figure 1 Vacu-tug pit latrine exhauster



yearly growth rate is estimated at 12%. Excreta disposal is mainly by traditional pit latrine. Although in theory most households have access to a latrine, in practice it is limited to 50-200 persons per latrine. Apart from the problem of over-full pits, the density of occupation precludes the digging of new pits.

The trial was arranged in association with Nairobi City Council through the primary health care unit of the Public Health Department. Their consent was required for the disposal of the sludge to the municipal sewer. The Chief of Kibera was also consulted during the planning stages. The vacu-tug was established as a micro enterprise with Kibera residents visiting the KWAHO office within the area and paying the fee up front. Appropriate record ke eping and monitoring of the operations were also established to ensure full operational data were available. The vacu-tug is operated by two trained operators who are also responsible for daily maintenance. Monthly maintenance is carried out by a local mechanic. During the first week of operation the maximum no. of loads per day was 9. The maximum distance between anywhere in the low-income area and the nearest sewer manhole is 2 km. The operations are therefore planned so as on a certain day a particular area was serviced. A willingness to pay study was undertaken to set the price for desludging for the consumer.

RESULTS

The machine has now been operating within the low-income area for a total of 27 days during the period January - July 1996 (which covers both wet and dry seasons in Nairobi). During this period the vacu-tug has emptied over 80 pits eqivalent to 197 loads and has reduced the expenses of service provision for most households and landlords. The cost of 6 loads is equivalent to the cost of digging 1ft depth of latrine. The vacu-tug has proved capable of negotiating many of the dwellings within the settlement which would not normally be accessed.

Some operation problems were encountered and as a result small design modifications have been made. In terms of operational problems, there were some delays experienced in the project execution due to the theft of the engine and vacuum pump. This has necessitated replacement and improvements in the security arrangements for garaging of the vacu-tug. Problems were also reported by the operators during the rainy periods when traction of the vehicle, especially when full, was difficult. Minor problems in the design of the vacu-tug have emerged as a result of the exhaustive field trials but these have been resolved without affecting operation. The modifications were, in most cases, suggested by the operators. A theoretical analysis of the capital and operational costs which were established at the projects outset were as follows:

Capital costs per annum

Capital cost of vehicle	US$ 5,000
Economic life	4 years
Interest rate	20%
Maintenance	10%
Depreciation (25% x US$ 1,500)	US $ 1,250
Interest on capital (20% x US $ 5.000)	US $ 1,000
Total capital costs	**US $ 2,250**

Operating costs per annum

Maintenance 10% x US $ 5,000	US $ 500
Labour costs 2 x Ksh 2,000/month	US $ 900
Fuel costs 3 litre x 35 Ksh x 5.5 day x 52 weeks per year	US $ 566
Oil	US $ 200
Total operating costs	**US $2,186**
TOTAL ANNUAL COSTS	**US $4,416**

Income

Assume 8 loads (of 400 litres) per day x 5.5 days per week x 52 weeks per year = 2,288 loads per year. Assume 2,000.

Total "prime" cost per load = 4,416/2000 =	US $ 2.2
Charged Cost per load = Ksh 250	US $ 3
Profit and operating overhead =	**36%**

At a theoretical waste generation rate of 50 l/cap/annum

Cost = US $ 0.3/caput/annum

Table 1 indicates the volumes of sludge collected during the first few months of the trial. It can be seen that the volume collected is approaching the maximum estimated to completely cover capital and operational costs. The low figures in May and June are due to the rainy season making traction difficult.

Table 1 Volumes of Sludge Collected during trial period (estimated maximum =4000 l/d)

Month	Average volume of sludge collected per day (l/d)
January	3200
May	1750
June	1750
July	2500

CONCLUSIONS

The vacu-tug has proven an efficient means of providing an exhaustion service in a low income area where conventional systems are unaffordable and unable to gain access. The price for desludging was set to cover full operations and maintenance costs. The price was also significantly less that the costs of digging a new latrine.

Minor operation difficulties were encountered with the prototype but were quickly modified based on advice from the operators. Difficulties were experienced during the rainy season and this may effect operations. Every effort must be made to ensure that the desludging apparatus is stored in a safe place to prevent theft.

When established as a micro-enterprise within a low income settlement, the system performed well and according to current results would be sustainable without external assistance.

Further field-testing will be required to establish a full economic analysis of the system and to develop methods to dispose of the sludge where a local authority sewer is not readily available.

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