

Inefficient technology or misperceived demand: the failure of Vacutug-based pit-emptying services in Bangladesh

AFTAB OPEL and M. KHAIRUL BASHAR

Demand is growing globally for appropriate technology and viable business solutions to pit-emptying and transportation services. There is a growing body of experiments on technological innovations in different contexts to find an effective solution. However, there is no one technology or business model that can be applied everywhere because of contextual difference and varied demand. A Vacutug-based emptying and transportation service has been introduced in an urban context in Bangladesh by WaterAid. However, this study suggests that despite enormous demand, this mechanical emptying and transportation service has not been successful because of technological inefficiency and other demand-related factors.

Keywords: pit emptying, urban sanitation, faecal sludge management, Vacutug

INCREASING SANITATION COVERAGE in many developing countries in Asia and Africa has led to a tremendous rise in on-site sanitation because it is cheaper than sewerage systems (Franceys et al., 1992; Trémolet et al., 2010), affordable for low-income people (Cairncross et al., 2010), and can be built at household level without much involvement of the authorities. This rise of on-site sanitation has created a huge demand for pit and septic tank-emptying and transportation services to keep the toilets running. However, there has been little consideration given to how to deal with the pits and septic tanks once they are full (Thye et al., 2009). There has been a widespread knowledge gap about the importance and means of efficient pit emptying, which is seen as the 'dark underbelly of on-site sanitation – mostly neglected, stigmatised, and inadequately acknowledged as an essential component of sustainable sanitation' (Eales, 2005). Many developing countries are struggling to find viable technological and business solutions to pit and septic tank emptying without which the gains of improved sanitation coverage fail to bring desirable benefits (Opel, 2012; Chowdhry and Kone, 2012).

Safe emptying, transportation, and disposal of sludge is extremely important for public health as well as for the social and environmental benefits it brings (Franceys et al., 1992; Eales, 2005). It is considered to be one of the principal means of breaking the faecal–oral disease transmission cycle (Howard, 2002; Shordt, 2006),

Aftab Opel (aftab.opel@wateraid.org) is Research Manager, WaterAid Bangladesh.

M. Khairul Bashar (faircon@dhaka.net) is Chief Executive, FAIRCON Management Services.

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which is highly associated with the reduction of child mortality (Esrey et al., 1991) and a powerful measure to control the transmission of helminth infections (Esrey, 1996). However, service sectors and the markets are still struggling to find efficient and viable solutions to meet the increasing demand. Emptying and transportation is often done by the manual emptiers, who, for practical reasons, do not transport emptied sludge to a safe distance for disposal. As a result, the risk of faecal matter re-entering the domestic environment remains high, which is a great public health concern (Ingallinella et al., 2002; Eales, 2005; Opel, 2012).

Manual emptying is most hazardous as the emptiers usually do not use anything other than some buckets and a plastic drum to transport sludge. Manual sweepers do not even use any gloves to avoid contact with sludge. In a few instances, they use pump machines to pump out liquids from the septic tank or pit and then empty the remaining solid sludge manually. This saves time but the liquid is usually pumped out to nearby drains, canals or water bodies. Thus, the method is extremely harmful for both the emptier and the environment.

There have been some experiments on pit emptying and transportation using mechanical methods (Howard, 2002; Shordt, 2006). However, most of these technologies are context specific and replicable to a limited scale. There has been little study of the business potential and profitability of emptying and transportation services. A recent study in 30 cities in Asia and Africa, of which this study is a part, compiled financial statements of 154 emptying business and concluded that emptying and transportation of faecal sludge is a profitable business when operated by private entrepreneurs (Chowdhry and Kone, 2012). This paper is an exploration of why the services provided by the two non-profit organizations and two municipalities in Bangladesh could not run profitably.

Methodology and data

This paper uses household and business-level data from three cities in Bangladesh which have at least one mechanized pit and septic tank-emptying service (Dhaka, Khulna, and Faridpur). Households were selected randomly in each of the cities. Information from a total of 1,220 households was collected in three cities. A semi-structured questionnaire was used to interview households to find out their pit and septic tank-emptying practices and preferences for improved services. A statistically representative sample was drawn in each of the cities, with a total sample of 467 households for Dhaka, 395 households for Faridpur, and 358 households for Khulna being selected and interviewed. At the provider level, the financial records were analysed for both mechanical and manual emptying services in order to compare financial performance. Income statements were prepared for the agencies (NGOs and municipalities) engaged in mechanized emptying. Income statements for manual emptiers were also prepared to compare their performance with the mechanized emptying.

Profile of the service providers

Dhaka Water Supply and Sewerage Authority (DWASA) is the responsible governmental body providing sewerage services in Dhaka city. However, DWASA does not provide any emptying and transportation services to those using on-site sanitation (OSS), despite the fact that almost 80 per cent of the city is not served by the piped sewerage coverage. To fill this service gap, two non-governmental organizations (NGOs), namely Dustha Shytha Kendra (DSK) and Population Services and Training Centre (PSTC), started mechanized emptying and transportation services with technical and financial support from WaterAid. Both organizations provide the service using the locally made Mark2 type of vacuum tug of 2 m³ capacity.

Faridpur and Khulna municipalities provide the mechanized emptying and transportation services in the respective cities. Khulna municipality uses the Mark2 type of vacuum tug of 2 m³ capacity while the Faridpur municipality uses the Mark1 type of vacuum tug with 0.6 m³ capacity. The service in Faridpur is supported by Practical Action (an international NGO) while the service in Khulna was supported under an Asian Development Bank (ADB) funded project. Brief profiles of the emptying service providing agencies are given in Table 1.

Table 1 Profiles of the mechanical emptying services

| | <i>DSK</i> | <i>PSTC</i> | <i>Faridpur municipality</i> | <i>Khulna municipality</i> |
|---|--------------------------|--------------------------|------------------------------|----------------------------|
| Year of establishment | 1989 | 1978 | 1869 | 1884 |
| Legal entity | National NGO | National NGO | Municipality | Municipality |
| Year mechanical emptying service commenced | 2000 | 2009 | 2009 | 2003 |
| Source of initial funding | WaterAid | WaterAid | Practical Action | ADB |
| Vacuum tug in operation (capacity) | 1 (2 m ³) | 1 (2 m ³) | 1 (0.6 m ³) | 1 (2 m ³) |
| Model of vacuum tug | Mark 2 | Mark 2 | Mark 1 | Mark 2 |
| Manpower (regular) | 3 | 1 | 1 | 1 |
| Manpower (on-call basis) | 1 | 3 | 1 | 1 |
| Area coverage | 797 km ² | 797 km ² | 22.39 km ² | 45.64 km ² |
| No. of pits/septic tanks emptied in last year | 280 | 20 | NA | NA |
| Average charge per trip | US\$7.14 | US\$7.14 | US\$7.14 | US\$14.28 |

NA: not available

Demand and supply of emptying service

Only Dhaka city has a piped sewerage network, which covers about 20 per cent of the city. The other two cities do not have a piped sewerage system (Opel et al., 2011). The prevalence of open defecation in all three cities is also very low. Therefore, the actual on-site sanitation in Dhaka is nearly 80 per cent while in the other two cities it is over 98 per cent. This suggests that the demand for pit and

Table 2 Demand for on-site sanitation in three cities

| | <i>Dhaka</i> | <i>Khulna</i> | <i>Faridpur</i> |
|--|--------------|---------------|-----------------|
| Total population (in 2011) | 15,018,594 | 1,728,760 | 146,667 |
| Total no. of households (in 2011) | 3,337,470 | 384,169 | 24,840 |
| Total daily production of FS (m ³) | 2,740,893 | 315,499 | 26,767 |
| Coverage under sewerage system (%) | 20.00 | 0.00 | 0.00 |
| Open defecation, hanging, etc. (%) | 0.77 | 0.77 | 1.50 |
| Coverage under OSS (%) | 79.23 | 98.23 | 98.50 |

FS: faecal sludge; OSS: on-site sanitation

septic tank emptying and transportation in all three cities is very high. Since all the cities are expanding geographically with high population growth rates and there are no ongoing or planned projects to expand the existing system or introduce piped sewerage systems, the demand for pit and septic tank emptying is expected to grow over time. A demand calculation in three cities is presented in Table 2. Production of faecal sludge was calculated based on per capita per day sludge production.

Service coverage data collected at the household level suggests that the informal manual emptier dominates the markets. In all three cities, less than 1 per cent of the service is covered by a mechanical emptier in the formal sector (NGO or the municipality). A comparison of finances between manual and Vacutug-based mechanical emptying suggests that in Dhaka the expenses for a household are almost equal, US\$17.08 and \$17.26, respectively, for manual and mechanical emptying. This is because the service is provided to the low-income households by the NGOs at a subsidized rate. In the other two cities, the actual expense for mechanical emptying is about three times higher than the manual emptying. Service coverage by the two types of providers is presented in Table 3.

Table 3 Coverage by different types of service providers

| | <i>Dhaka</i> % | <i>Khulna</i> % | <i>Faridpur</i> % |
|-----------------------------|-------------------|--------------------|----------------------|
| Informal providers (manual) | 99.67 | 99.03 | 99.84 |
| NGOs | 0.33 | 0.00 | 0.00 |
| Municipality (mechanized) | 0.00 | 0.97 | 0.14 |
| Total | 100.00 | 100.00 | 100.00 |

Comparative profitability analysis

Profitability analysis of all four mechanical emptying service providers suggests that none of them has made any profit in their business since they started. A similar study on the service of DSK in 2008 suggested that the income covered the operational and maintenance costs but was not sufficient to repay capital investments, which limits the capacity of DSK to scale up the operation or other NGOs to replicate the service in other towns (Jonathan and Masudul, 2008). Another study on the

Table 4 Comparison of profitability per year (in US\$)

| | Manual emptier | Mechanized services | | | |
|---------------------------|-------------------|---------------------|---------|--------------------------|------------------------|
| | | DSK | PSTC | Faridpur municipality | Khulna municipality |
| No. of trips per year | 120 | 744 | 192 | 144 | 960 |
| Revenue | 1,889 | 10,629 | 2,771 | 1,029 | 13,714 |
| Personnel costs | 0 | 7,909 | 1,517 | 1,543 | 2,743 |
| Operation & dumping costs | 686 | 3,686 | 1,265 | 134 | 3,737 |
| Capital costs | 3 | 1,007 | 2,192 | 1,121 | 7,664 |
| Total costs | 689 | 12,602 | 4,975 | 2,798 | 14,144 |
| Profit/(loss) per year | 1,197 | (1,973) | (2,203) | (1,769) | (430) |

service of Faridpur municipality conducted in 2011 suggested that the municipality incurred huge financial losses in running the vacuum-tug-based pit-emptying service (Yousuf and Mahmud, 2011).

Table 4 provides a comparative profitability analysis of one year for each of the service providers and compares them with a manual emptier, which suggests that manual emptying is a lot more profitable than the mechanical emptying in different urban contexts in Bangladesh. Despite this huge financial loss, municipalities may continue to provide this service for environmental and public health reasons, but it might not be viable for the NGO to run such a business sustainably.

Inefficient technology or misperceived demand: underlying factors of low uptake of mechanized services

Factors related to cost of service and willingness to pay. The cost of both types of service is almost equal in Dhaka but the cost of the mechanical emptying service is higher in Khulna and Faridpur. However, household-level data suggests that cost of service is not the key factor for a household to choose a particular method of emptying or a particular type of service provider. As presented in Figure 1, less than a quarter of the households mentioned that they choose manual emptying because of the low price compared with mechanical emptying, while 81 per cent of households mentioned that the ease of using the service is the main consideration for them; 10 per cent of households said that they choose the manual emptying service because they are flexible time-wise. The service from the manual emptier is available at any convenient time for the household, including weekends and holidays, which is not possible from the formal mechanical service providers. Household-level data furthermore suggest that most people in all three cities are willing to pay more for better services. So, the cost of the service is not the key driver for the unprofitability of the mechanized services.

Factors related to demand for service. Although only 20 per cent of Dhaka city is covered by the piped sewerage system, the other 80 per cent of the city should ideally use on-site sanitation that requires pit and septic tank emptying when they

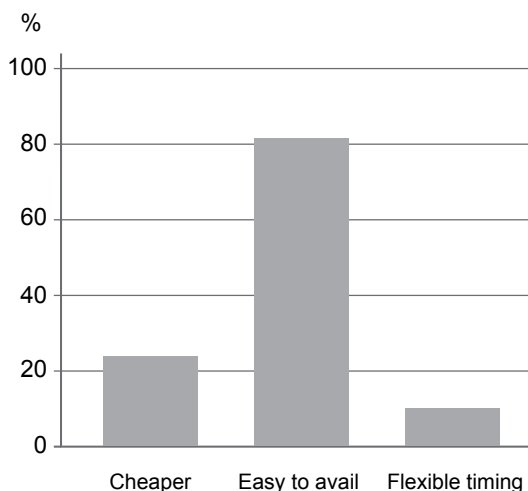


Figure 1 Reason for choosing a particular type of emptying

are full. However, the reality is somewhat different. A recent study reported that 84 per cent of the septic tanks and pits in the areas outside the sewerage coverage areas are directly linked to the storm drainage system that is connected to the rivers outside the city (Opel and Islam, 2013). These pits and septic tanks do not require emptying. As a result, the actual demand for emptying services in Dhaka city is significantly reduced, which might affect the profitability of the emptying service provided by the two NGOs in Dhaka. This is not the case in the other two cities since there is no drainage system available to connect the pits and septic tanks to.

Factors related to technology. Locally made vacuum-tugs are used by all four service providers in all three cities. However, this analysis suggests that this technology has certain limitations in providing a service with quality and efficiency in the urban context in Bangladesh. As a result, businesses cannot flourish and the providers are incurring huge losses. Some of the limitations of Vacutugs are as follows:

- *Time intensive (transportation).* The models of Vacutugs (Mark1 and Mark2) being used by the four service providers are very slow-moving devices. As a result, using them to empty and transport is very time intensive since they have to travel long distances to discharge the sludge into the dumping sites. It usually takes 8–12 hours for a Vacutug to empty an average-size septic tank of a residential building, which most households do not like.
- *Cannot climb inclines of more than 3 per cent.* Because of the low-powered engine used in the Vacutugs, they cannot climb more than a 3 per cent incline. There are many small bridges and culverts in the roads of Bangladesh. As a result, these models are not very efficient for transporting sludge from the pit to the dumping site.
- *Difficult to move through narrow roads.* Roads in the low-income settlements are usually very narrow, while demand for emptying is very high in these areas

because of the high user-to-toilet ratios in the low-income settlements. The Vacutug models used by the four service providers often face difficulty in moving through narrow roads; as a result, they avoid servicing those areas.

- *Short pipe length.* Owing to the short pipe length, these Vacutugs cannot be operated from a longer distance to empty sludge from slum or high-density settlements.
- *Maintenance difficulty.* Engine maintenance of these Vacutugs is very difficult. It was reported by the users that each time they had any difficulty with the engine they had to call on the manufacturer to fix the problem, which is usually time intensive and costly.

Factors related to management. Accessing services from the municipality usually takes time. Bureaucratic processes and paperwork required to access the service usually discourage people from using the mechanized emptying services provided by the two municipalities. Particularly for the low-income groups, accessing services from the municipality is even more difficult. Cost is also a key driver for these groups of people; as a result, they prefer to use the manual emptier. Municipalities and NGOs do not work on weekends and holidays, but the households usually prefer to get their pits emptied at weekends when they are at home in order to supervise the work. All these factors are important reasons for the households to prefer the manual emptying service, which eventually leads businesses to incur losses.

Conclusion

In a context where demand is very high, competition is very low, and people are willing to pay more for better services, it is surprising to see that emptying and transportation businesses are incurring huge losses and that services are not sustainable. Vacutug-based emptying services introduced and experimented with at the government level as well as at the non-governmental level could not be sustained for a combination of reasons that include both technological inappropriateness and management limitations. It is therefore important to consider that without a comprehensive system, mere introduction of a business model comprising one or two components may not be a stand-alone solution to address this huge problem of faecal sludge management. It is important to work at different levels and pilot different approaches and context-specific technologies so that the successful working model can be scaled up.

This analysis has identified a number of limitations of the available models of 'Vacutug' being operated in Bangladesh. However, it is highly unlikely that some adjustment and upgrading of these models could work better in the complex urban contexts in Bangladesh. It is therefore important to take into account the factors that might construct functional demand and uptake that may make the business viable. On the other hand, it is equally important to acknowledge that technology is not the only thing that ensures sustainability. As the paper argues, it is important to formulate a management model that could cater for the demands of a wide range of clients for it to be sustainable.

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