The Efficacy of Low-cost Technologies to Improve Traditional Sludge Practices in Madagascar

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• 22 million inhabitants, 7.5 million in urban areas
• 81% sanitation coverage in urban communities
• Sludge removal done by informal day laborers
• No public treatment plants, dumping and burial the norm
Population: 40,000
Toilets: 3,520
Dry Pits: 82%
Septic: 18%
Demand: 600 pits/year
Desludging Tools

- The Gulper: clogged in 70% of cases, 0.8 m3/h (when working)
- Diaphragm handpump: relatively costly ($1,000) but more efficient than the gluper, 0.8 m3/h yield
- Diaphragm motor pump: high up-front investment, 2 m3/h yield
- Shovels or rope and bucket: adaptable to all pit types, handling is messy, 1.2 m3/h yield

Containment and Transport

**Trailer:** 1,000 liter capacity, local fabrication, ideal for septic systems adjacent to the road

**Barrel:** 60 liter

Advantages > Disadvantages:

**Cart:** Proved to be an important tool when using the barrels
Results after 6 months

**Tariff**: $31 / m³

**Breakdown of Costs of the $31/m³ Fee**

- Promotion: $0.75
- Administration (telephone...): $2.27
- Maintenance & supplies: $2.87
- Profit: $4.01
- Sludge treatment: $4.34
- Transport: $8.00
- Workers: $8.50

**Evolution of FSM Service by Month**

- March: 0
- April: 5
- May: 15
- June: 20
- July: 25
- August: 30
- September: 35

Note: The dashed line indicates profitability.

- Demand confirmed
- Technical solutions tested
- Business tracking tools developed
- Sludge characteristics identified

**Service not maintained...**

**84m³ treated**
Population: >300,000
Toilets: 22,900
  - Drum latrines: 20%
  - Dry Pits: 24%
  - Pour-flush: 18%
  - Septic: 38%
Demand: 2,380 pits/month
Sludge Production: 15,000 m3/yr
Situational Analysis: FSM in Tamatave

200 – 300 emptiers

Volume of Sludge Treated per year

98%

1 Private operator

300 m³

On site burial
14,700 m³
**Approach:** Collect sludge from different latrine types and transport to centralized location in town for transport to private treatment plant.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Truck (4x4)</th>
<th>Kubota</th>
<th>Tricycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (m3/trip)</td>
<td>1.0</td>
<td>1.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Accessibility to the yard</td>
<td>28%</td>
<td>36%</td>
<td>32%</td>
</tr>
<tr>
<td>Type of Pit</td>
<td>Septic</td>
<td>All</td>
<td>Drum</td>
</tr>
<tr>
<td># of operators</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Type of equipment</td>
<td>Motor pump</td>
<td>Diaphragm /hand tools</td>
<td>hand tools</td>
</tr>
<tr>
<td>Removal speed (m3/h)</td>
<td>0.5 - 0.9</td>
<td>0.4 - 0.5</td>
<td>0.4 - 0.5</td>
</tr>
<tr>
<td>Speed when full (km/h)</td>
<td>30</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>Investment Cost ($)</td>
<td>15,000</td>
<td>5,000</td>
<td>500</td>
</tr>
</tbody>
</table>

**Truck:** 4x4 with trailer, 1m3 of barrel capacity, motor pump 4kW and diaphragm pump

**Light tractor with Cart:** Equipped with a diaphragm pump and 25 barrels (1m3 capacity)

**Tricycle:** Equipped with 5 barrels (200L capacity) and rustic extraction tools

Centralized collection is not yet possible...
Business model: The organization of 4m³/day in Tamatave

- Pre site visit
- Aggregated demand
- Multiple sites emptied simultaneously
- Sludge is stored temporarily in barrels on the property of the client
- All sludge collected is transported to the dumping site using a rented truck (3 ton) (or tractor 5 ton)

Tariff: $30 / m³
Current business model: service requires an average of 4m³/day for at least 11 days per month to become profitable

<table>
<thead>
<tr>
<th></th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Volume Treated</strong></td>
<td>26.3</td>
<td>29.8</td>
<td>38.2</td>
<td>43.1</td>
<td>42</td>
<td>42</td>
<td>221.58</td>
</tr>
<tr>
<td><strong>Average Volume / visit</strong></td>
<td>1.0</td>
<td>0.8</td>
<td>1.0</td>
<td>1.6</td>
<td>1.3</td>
<td>1.4</td>
<td>-</td>
</tr>
<tr>
<td><strong>Number of clients</strong></td>
<td>26</td>
<td>37</td>
<td>40</td>
<td>27</td>
<td>33</td>
<td>30</td>
<td>184</td>
</tr>
<tr>
<td><strong>Days Worked</strong></td>
<td>11</td>
<td>18</td>
<td>20</td>
<td>18</td>
<td>22</td>
<td>17</td>
<td>-</td>
</tr>
<tr>
<td><strong>Volume / day worked</strong></td>
<td>2.4</td>
<td>1.7</td>
<td>1.9</td>
<td>2.4</td>
<td>1.9</td>
<td>2.48</td>
<td>-</td>
</tr>
<tr>
<td><strong>clients/volume Septic</strong></td>
<td>11/13.8</td>
<td>22/22.7</td>
<td>22/25.6</td>
<td>14/28.8</td>
<td>19/31.4</td>
<td>11/26.4</td>
<td>94/122.2</td>
</tr>
<tr>
<td><strong>clients/volume Dry Pit</strong></td>
<td>1/0.2</td>
<td>2/1.7</td>
<td>-</td>
<td>1/1.0</td>
<td>2/2.44</td>
<td>5/4.15</td>
<td>8/3.8</td>
</tr>
<tr>
<td><strong>clients/volume Drum Latrine</strong></td>
<td>8/1.6</td>
<td>9/1.6</td>
<td>11/2.0</td>
<td>-</td>
<td>5/1.1</td>
<td>5/1.35</td>
<td>49/9.0</td>
</tr>
</tbody>
</table>
Rustic tools are required for FS removal; the standardization of toilets to allow for the simplification of FSM operations would increase efficiency.

Equipment and transport options are available locally to start a FSM business without heavy up-front capital costs; profitability depends on market aggregation and the organizational capacity of the entrepreneur; more innovation in the business model is needed.

Septic tank users are the primary clients of professional FSM services; policy changes (i.e. targeted subsidies or other incentive structures) may be required to encourage adoption by the poorest quintiles.