DEVELOPMENT OF URBAN SEPTAGE MANAGEMENT MODELS IN INDONESIA

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ABSTRACT

Almost half of Indonesia's 238 million people live in urban areas.[1] *As part of the Government of Indonesia's Acceleration of Sanitation Development in Human Settlements Program, the use of on-site sanitation systems in urban areas will continue. In dense areas, small decentralized wastewater treatment systems will also be used, resulting in increasing demand for septage emptying services too. Foreseeing this demand, the Ministry of Public Works has evaluated the design and performance of many existing septage facilities in preparation for rehabilitation and new construction. The evaluations concluded that in many cities there was sub-optimal ownership of the septage treatment facilities by local governments; the institutional arrangements for operating the facilities and the operation and maintenance budgets were poor, and the staffing and staff capacity was low.*

In late 2011, the Ministry of Public Works requested technical assistance to support national investments in septage infrastructure, focused on helping local governments improve urban septage management. In particular, the assistance was aimed at developing sustainable management models for operating and maintaining septage systems.

This paper will outline the findings of field work in two Indonesian cities. It will focus on the proposed models for Tegal (pop 250,000) in Central Java and Jombang (pop 200,000) in East Java. The key areas of presentation will address:

- *Current septage system practices and shortcomings*
- *Incentives and disincentives to local Government for improved operation*
- *Proposed management models, with potential for extending the sanitation value chain by reuse of septage*
- *short and medium term actions for local government*
- *Application of lessons learned for other cities in East Asia and elsewhere*

Key words: SEPTAGE, INDONESIA, MANAGEMENT MODELS, FAECAL SLUDGE

[1] 2010 census preliminary results Badan Pusat Statistik Republik Indonesia (Statistics Indonesia) http://dds.bps.go.id/eng/tab_sub/view.php?tabel=1&daftar=1&id_subyek=12&notab=1 viewed 5 Mar 2012.

INTRODUCTION

Sanitation coverage in Indonesia is high, on average more than 80% in urban areas. Most sanitation facilities are on-site, with faecal material stored in some form of tank or pit and requiring removal from time to time. After removal, faecal sludge has to be transported to a place where it can be treated before reuse or disposal to the environment if the health of workers and consumers and the quality of the environment are to be safeguarded.

Recognising that on-site sanitation and will continue to be the norm the use of decentralised system is increasing for the foreseeable future, the Directorate General of Human Settlements (Cipta Karya) of the Ministry of Public Works is currently rebuilding or renovating septage treatment facilities (*instalasi Pengolahan Lumpur Tinja)* in more than 100 cities. Other cities are investing in septage treatment with funding provided by international development partners, for instance through the AusAID-funded Indonesia Infrastructure Initiative (IndII). The new facilities will only be effective if adequate quantities of faecal sludge are delivered to them and they are operated in a way that ensures that this sludge is adequately treated. At present, neither condition is adequately fulfilled. Indeed, less than 10% of the 150 sludge treatment facilities constructed in the 1990s were still functional by 2009. A recent estimate suggests that less than 4% of Indonesia's septage is treated at a treatment plant[2].

In order to address these challenges, WSP and USAID's Indonesia Urban Water, Sanitation and Hygiene (IUWASH) are working with the Government of Indonesia to develop business models for faecal sludge removal, transport, treatment and, if possible, reuse, drawing on the lessons learnt from field investigations in a number of Indonesian towns and cities. This paper sets out the findings from field work in the first two towns investigated by WSP, Jombang in East Java and Tegal in Central Java. Jombang town is located in the district (*kabupaten*) of Jombang. It is not a designated city or separate administrative division. The 2010 census reported a population of 1,201,557 for the entire regency (*Kabupaten)* while the population of Jombang sub-district (*Kacamatan*) was reported as 137,097. However, the potential market for faecal sludge management services as higher, including the town of Jombang and the 20 villages within Jombang sub-district. Tegal is a city with its own local government. It comprises four sub-districts and 27 communities and its registered population and number of households in 2010 were 240,540 and 63,948 respectively[3]. Both Jombang and Tegal have existing treatment facilities and the one in Tegal is currently being replaced by a new facility on the same site.

EXISTING FACILITIES AND SYSTEMS

Sanitation facilities

Sanitation coverage in both Jombang and Tegal is high, at 91% and 96% respectively[4]. Some facilities are conventional septic tanks discharging treated wastewater to either a soakaway or a drain field but the majority are '*cubluks*' tanks or pits with an earth bottom that allows wastewater to soak away into the subsoil. In essence, a *cubluk i*s a leach pit although the lack of openings in the side walls means that they are dependent on seepage from the base, which is likely to be greatly curtailed as sludge builds up in the bottom of the tank and blocks the percolation path.

The households visited in Tegal all had large unventilated open-bottom tanks, located under the house, usually under the kitchen, and with no visible access for removing the septage. Estimated volumes varied from one to eight cubic metres. Four of the tanks had been in place for over 5 years, the largest for around 10 years, and had never been emptied. Of three households visited in Jombang, two had large

[2] A Rapid Assessment of Septage Management in Asia, USAID, EAWAG and WaterLinks, 2010.

[3] The Health Department (Dinas Kesehatan) estimated population and number of households in December 2011 were slightly different at 256,935 and 62,114 respectively but the figures are close enough to provide an overall picture of population and household size in Tegal.

[4] The figure for Jombang is for Jombang Kecamaten, coverage is surrounding kecamatens is lower. The figure for Tegal is for the kota.

unventilated, open-bottom tanks, as in Tegal located under the kitchen floor, with no visible access for septage pump-out. The third, at a property which rented out rooms, had large ventilated tanks that were reported to be sealed and had provision for pump out. Estimated tank volumes varied from one cubic meter to five cubic meters. Two of the households visited in Tegal had had their tanks desludged in the last five years. This required the removal of ceramic floor tiles, forming a hole in the floor and subsequent reinstatement, which in one case was stated to have cost more than the desludging itself. This requirement would appear to apply in most situations.

Analysis suggests that large tanks can go for many years without desludging. Assuming that well-digested sludge accumulates at a rate of 35 litres per capita per year and an average family size of 4, a five cubic metre cubluk could last 35 years without desludging. The more immediate problem relates to poor infiltration rates through the cubluk base. The lack of access covers for septage pump-out and visible discharge pipes, suggests that the common response is to make a high level connection between the pit and the nearest drain or water body so that excess liquid can escape. Digested and partly digested sludge is carried out of the cubluk in suspension, reducing the frequency with which the tank has to be desludged or even eliminating the need for desludging altogether. This practice greatly reduces the need for desludging but at the expense of the environment as polluted wastewater escaping from pits contaminates the receiving water bodies.

Sludge removal and transport services

Many municipalities in Indonesia , including Jombang and Tegal, provide tank desludging services but in both places the majority of tanks are emptied by private sector firms with vehicles that have been specially adapted for sludge removal. Each vehicle carries a desludging pump and a tank, into which the sludge is pumped for transport. Most vehicles are small trucks or pick-ups although one operator in Tegal used a tricycle. The private firms are small. Of four identified in Jombang, three operated one vehicle and the fourth had two vehicles. Tank capacities on trucks varied between 1.7 and 3.5m3, on average about 2.3m3. Interviews with seven firms in Tegal, revealed that each operated one vehicle and that vehicle capacities varied from 0.9m3 to 3m3, with an average of 2.2m3. Only one operator, in Tegal, was officially registered and he and others said that the registration process was difficult. He added that registration had provided few benefits.

Sludge tanker drivers claim that they deliver most of their sludge loads to the treatment facility but this was not supported by the facility records, which registered averages of only 19 loads and 10 loads per month in Tegal and Jombang, respectively. This suggests that the majority of the sludge removed from pits and tanks in the two towns is either sold to farmers or discharged to the environment untreated. This conclusion is consistent with the finding, noted at the beginning of this paper, that only 4% of Indonesia's faecal sludge is treated.

Sludge treatment

Sludge treatment is required in order to render the sludge safe for either disposal to the environment or reuse in agriculture or aquaculture. This requires that the treatment facility be managed in a way that ensures that pathogen levels in the sludge are reduced to safe levels. The Tegal treatment plant consisted of an Imhoff tank and collector, one anaerobic pond, one facultative pond, one maturation pond, and a sludge drying bed. The total area of the site is about 3,000 m2. This is being replaced by a new similar plant, with three ponds and a sludge drying bed. The new Jombang facility has a reported capacity of 200m3/month and consists of an intake, a covered and vented stabilization lagoon, roofed drying bed, a filter and a maturation pond.

The purpose of the secondary ponds is to treat the liquid component of the sludge. The solid component is separated in the primary tank or pond and then dried on the drying beds. When separated from the liquid fraction of the septage, the solid sludge will contain a large number of pathogens and these must be removed if it is to be safely used. Detailed assessment of sludge treatment options to remove pathogens is beyond the scope of this paper but as a general rule pathogen removal can be achieved by composting or by drying sludge for several weeks[5].

Once treated, effective marketing and distribution systems must be in place if sludge is to be sold as a soil conditioner or fertilizer. There are precedents for this in Indonesia, and no substantial cultural or religious barriers[6].

Institutional and legal arrangements

In Jombang, responsibility for septage collection and septage treatment lies with the District Department of Public Works, Human Settlements, Spatial Planning and Gardening. This provides neither operational nor financial independence. In Tegal, septage management is the responsibility of a local business unit (UPTD) created by a regulation issued by the mayor. The UPTD falls directly under the head of the office of spatial settlement and governance and is divided into two units, one dealing with the solid waste landfill and the second with septage. Unlike a local government , the business unit can receive revenue but this must be transferred to local government accounts so that, this also provides no financial independence. In both towns, local government regulations set the fee to be charged for tank emptying and for private sector operators to discharge sludge at the treatment facility. In Jombang, there is a regulation explicitly prohibiting dumping of faecal sludge anywhere other than at the facility. In Tegal, a fine can be applied for failing to pay the charge levied when the UPTD truck pumps out a septic tank and a draft regulation has been prepared prohibiting improper septage dumping.

THE SANITATION CYCLE

In a world facing resource constraints, not least a lack of organic material to replenish agricultural soils, there is a strong argument for viewing sanitation as a cycle, in which excreta are collected, transported and treated before being returned to the land as a soil conditioner or fertilizer. The stages of this cycle as it applies to on-site sanitation systems are shown in Figure 1.

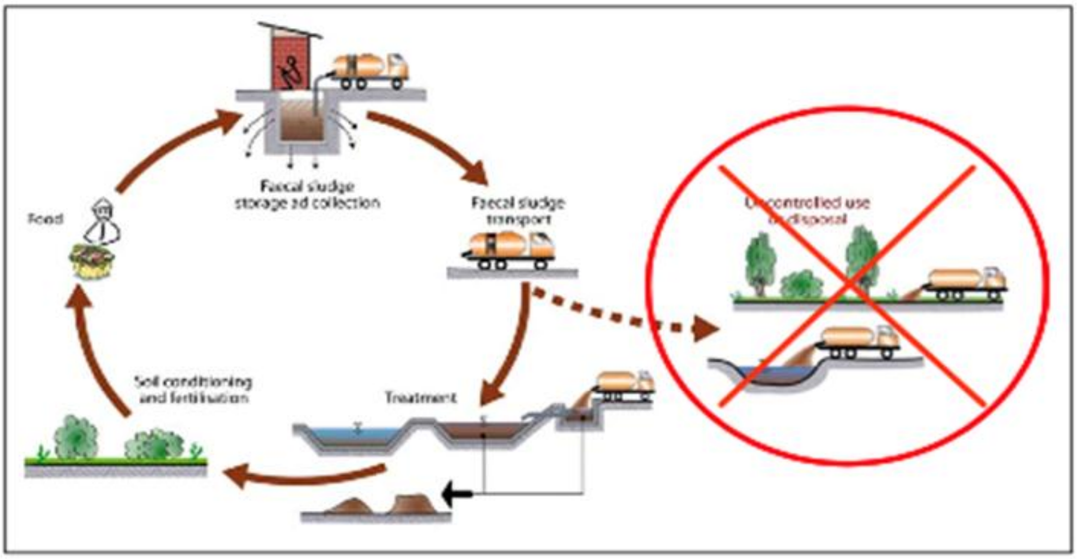

Figure 1 - Stages in the cycle of Human Waste Management

To complete the cycle, sludge must be collected from pits and tanks, transported to a treatment facility, treated to remove pathogens, packaged and distributed to farmers who apply it to their land. In practice, this cycle is being broken at several points. Some sludge always stays in pits and tanks and is left in place

[5] For information on the impact of co-composting on helminth eggs see Gallizzi K (2003). SANDEC/EAWAG-IWMI (2003) provide a general overview of knowledge on com-composting prior to thie Gallizzi study. Kengne et al (2009) report that retention of Long retention on drying beds reduced fertile ascaris eggs from 40 eggs/gram TS to less than 4 eggs/gram TS, within WHO guidelines

[6] Socio-economic aspects of EcoSan in Indonesia, WSP, 2009

when a facility is decommissioned, some escapes through high-level overflows into water courses and some is removed from pits and tanks but then dumped illegally or sold to farmers. The last completes the cycle but with a health risk for workers and food consumers. Figure 2 shows the paths currently taken by sludge, together with the path that needs to be followed if the cycle is to be completed, the latter as a thick black line.

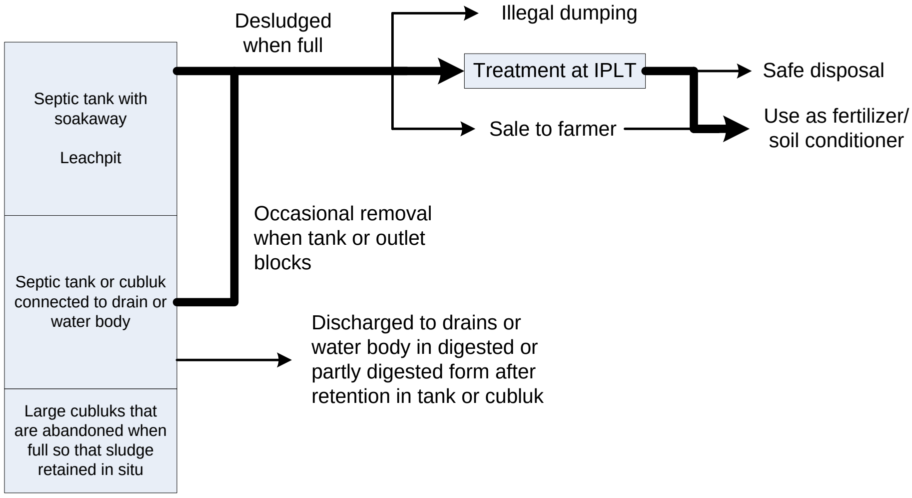

Figure 2 – Current and disposal paths for faecal sludge

Efforts to complete the cycle and improve sludge management business practices should be prioritized on the basis of:
(a) the relative importance of the various incomplete paths shown in Figure 2 and
(b) financial and other factors that affect current sanitation-related choices.

With this in mind, the next section uses the information collected in the field study to analyse the current situation in Jombang and Tegal.

ANALYSIS OF EXISTING OPERATIONS

Sludge production, removal and delivery to treatment facility

Table 1 presents the results of an approximate analysis, based on the available data on population, percentage toilet coverage, assumed per-capita annual faecal sludge production, reported number of pits and tanks desludged and recorded loads delivered to the sludge treatment facility.

Table 1 - Summary estimates for sludge production, removal and delivery

	Jombang		Tegal	
Monthly production of well digested sludge	384m^3/month		702m^3/month	
Monthly removal of sludge from tanks and pits	236m^3/month	61% of sludge produced	355m^3/month	51% of sludge produced
Monthly average recorded sludge delivery to treatment site	25m^3/month	11% of sludge removed	50m^3/month	14% of sludge removed

The sludge production figure for Jombang includes the potential to extend the sludge removal/transport to surrounding areas. The monthly sludge removal figures are based on sludge tanker driver estimates of the number of desludging trips that they have made, and are not likely to be exact. The figures for sludge delivery to the treatment facility are based on discharge records rather than the claims of sludge tanker drivers. While the records have been taken as the more reliable source of information, it is possible that some loads delivered go unrecorded. Despite these caveats, Table 1 provides strong indications that (a) a high proportion of the faecal sludge produced is not removed by septage tanker services and (b) a relatively small proportion of the sludge removed is being delivered to the treatment facility.

FINANCIAL VIABILITY OF PUBLIC AND PRIVATE SECTOR OPERATIONS

Sludge removal and transport

Table 2 summarises the available information on income sludge removal and transport businesses. The number of trips is based on estimates given by sludge vehicle drivers and so is unlikely to be accurate. The estimated profits are based on the average charges quoted by drivers for sludge removal and transport, less an allowance of USD5.5 per trip for fuel and other trip-related charges. The reported charges, and hence profits, differ between Tegal and Jombang, for reasons that are not clear. They may relate to the different size of sludge tankers but there is also a chance that drivers' estimates of average charges are incorrect.

Table 2- Summary information on income from removal and transport businesses

Location	Public sector			Private sector		
	No of trips Per day	Average profit IDR	Total income (IDR million)	No of trips	Average profit	Total income (IDR million)
Tegal	35	100,000 (USD 11.1)	3.5 (USD 389)	133	IDR 150,000 (USD 16.7)	19.95 (USD 2,217)
Jombang	35	150,000 (USD 16.7)	5.25 (USD583)	75	300,000 (USD33.3)	22.5 (USD 2,500)

From information provided by local informants, the direct fixed costs for public sector sludge removal and transport costs in Jombang and Tegal were USD 474 and USD585 respectively. The difference lies in the reported higher payment for the sludge tanker driver in Tegal, USD335 per month as opposed to USD220 per month in Jombang. In each town, an estimated USD889 per month was spent on the public sector sludge management, for both sludge removal and transport activities and the operation of the septage treatment facility.

Based on these figures, the Tegal local government business unit needs to empty about 53 tanks per month to cover its direct operating costs while the Jombang operation already appears to cover those costs. Neither operation covers management costs.

Assessment of likely private sector costs and income suggests that these businesses are only marginally viable. It is likely that costs are kept down by paying less than the official minimum wage, ignoring any legislation on social costs and not paying tax. Other strategies for ensuring a profit include selling sludge to farmers and using vehicles for other purposes. One operator in Tegal reported that he could remove the tank from his truck and use the truck for other purposes. Low private operator profit margins may provide an explanation as to why operators do not deliver sludge to the facility, where they will be charged USD 2.8 per load in Jombang and USD 1.7 per cubic metre in Tegal.

The apparently low profitability of private sector sludge removal and transport businesses has not deterred entrepreneurs from starting businesses. However, most operators have not been able to make optimal use of their resources with reported numbers of trips per vehicle ranging from 10 to 20 in Jombang and 10 to 30 in Tegal, giving an average of less than 20 trips per month or 1 per day in each town. The high number of private sector operators in relation to the current market for sludge removal may be, at least partly, a consequence of relatively low entry costs.

The figures given in Table 1 suggest that there is scope to increase the market for sludge removal and transport services. However, this will require action to encourage people to have tanks and pits desludged rather than allowing excess sludge to escape to the environment through connections to drains and water bodies.

Financial Viability of Septage Treatment Facilities

Figure 3 shows current financial flows for Tegal. The left hand column relates to collection businesses and the central column to the septage treatment facility. The situation in Jombang is similar, the only difference being that the facility is currently operated directly by the City rather than through a business unit.

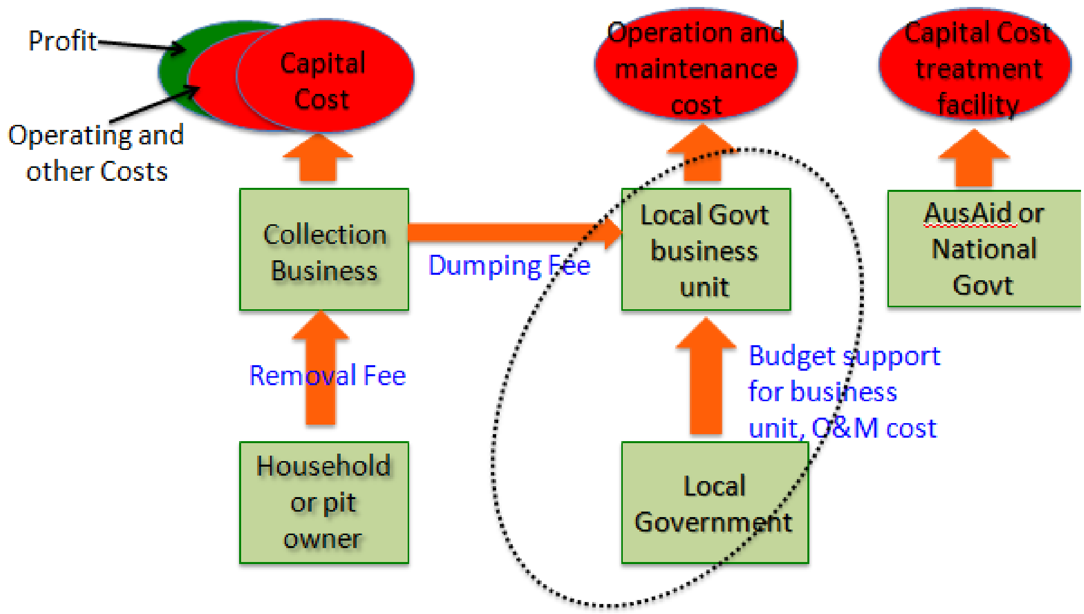

Figure 3: Current Financial Flows

Table 3 summarises the available information on expenditure and sludge charges for the Jombang and Tegal facilities, showing that at present both are heavily dependent on budget support.

Table 3 - Expenditure and income from charges at Jombang and Tegal sludge treatment facilities

	Jombang	Tegal
Estimated monthly direct expenditure on septage treatment facility	IDR 1.7 million (USD 189)	IDR 1.7 million (USD 189)
Estimated monthly management overhead	IDR4 million (USD 444)	IDR 4 million (USD 444)
Total monthly expenditure	IDR5.7 million (USD 633)	IDR5.7 million (USD 633)
Total sludge loads registered at facility/month	10	19
Private sector loads registered at facility/month	3.5	9
Charge per load	IDR 25000 (USD 2.8)	IDR 15000 (USD 1.7)
Current income from sludge delivery charges	IDR 87,500 (USD 9.7)	IDR135,000 (USD 15)
No of private sector loads to recover direct costs	68	57
No. of private sector loads to recover all costs	228	190

Most of the direct expenditure, USD 176 per month, is for the wage of a gatekeeper/collector, who is also responsible for operating the facility. The management overhead is taken as half of the USD889 per month estimated for all public sludge management-related activities. The figures for number of loads per month are based on IPLT records, covering a four month period for Jombang and a one year period for Tegal. Actual income for Tegal is based on the charge of USD1.67 per load that is reported to be levied in practice, while the estimates of numbers of loads required to cover costs are based on the prescribed charge of USD1.67 per cubic metre and an assumed average 2m3 volume per load.

There is potential for additional income from the sale of treated sludge. One estimate, based on retail prices charged by a small business in East Java, suggests that organic fertilizer using human waste as its main input could command a price of US$0.3/kg. Even if this price is realistic, it will only be realizable if (a) treatment processes are improved to guarantee treated sludge quality and (b) good marketing systems are put in place.

FINANCING OPTIONS

One option for covering IPLT operating costs will be to increase the market share of the public sector sludge removal and collection business so that it can cross-subsidise IPLT operations. This will be difficult if not impossible to achieve under any system that does not retain receipts within the sludge collection and treatment business. It might be possible under one of the improved management arrangements suggested at the end of this paper. However, a more promising medium to longer term approach will be to introduce a regular charge on all households to cover the cost of faecal sludge treatment. This option is shown in Figure 4.

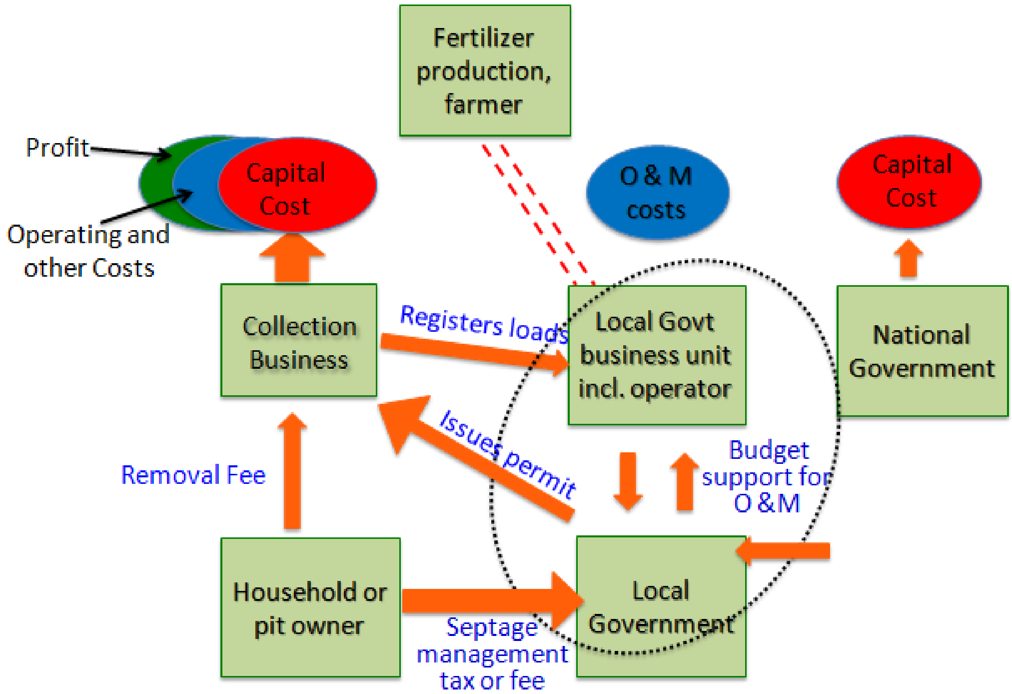

Figure 4: Financial Flows for "on call' Emptying System and regular payment for septage treatment

Under this scenario, sludge removal and transport would continue to be charged for directly by the operator providing the service, on the basis that waiving the disposal fee at the IPLT will be sufficient to provide an incentive for operators to use the IPLT rather than dumping sludge illegally or selling it to farmers.

Three options for collecting the septage treatment tax have been examined and include payment with the water bill, property tax or electricity bill. Payment with property tax appears to be the best option as there are plans to devolve responsibility for property tax collection to the local level. Payment with PDAM bills is simple and locally controlled but potentially inequitable as more than 50% of households do not have water connections. Almost everyone has an electricity connection but the bills are issued by a national level institution, making local collection a sanitation tax difficult. The option should not be ruled out but would need to be applied at a national or regional level rather than the city level.

This scenario is administratively simple but does not address the challenge of increasing the proportion of sludge removed from pits and tanks rather than being allowed to pollute drains and watercourses. Achieving this outcome will be aided by education and regulation so that that people (a) know what constitutes a proper sanitation facility looks (b) construct new facilities with provision for desludging and modify existing facilities to facilitate desludging and (c) arrange for regular desludging. Sludge removal and transport contractors might be encouraged to inform people of what constitutes good practice and even to report cubluks with connections to drains.

Further encouragement for regular tank emptying could be provided by increasing regular charges on all households to cover the cost of tank emptying and transport as well as sludge treatment. Tanks could still be emptied on an as-needed 'on-call' basis or a system of regular mandatory tank emptying to a pre-determined schedule could be started.

The 'on-call' system would require that the householder contacted the faecal sludge management 'authority' whenever he or she wanted a pit emptied and the authority would then have to either desludge the pit itself or contract a private sector operator to desludge the pit. This would require better record keeping and financial systems than a simple system covering only the operation of the IPLT. The advantage of this system would be that the financial disincentive to having the pit or tank emptied when full will be removed – if you are paying for the service anyway, there is no point in delaying calling a desludging truck.
The regular emptying option is shown diagrammatically in Figure 5. By ensuring that all pits are regularly emptied, this option should reduce surface water pollution caused by discharges from cubluk overflows. The kota authority could manage desludging operations itself or enter into a contract with one or more private sector contractors to do the desludging on its behalf.

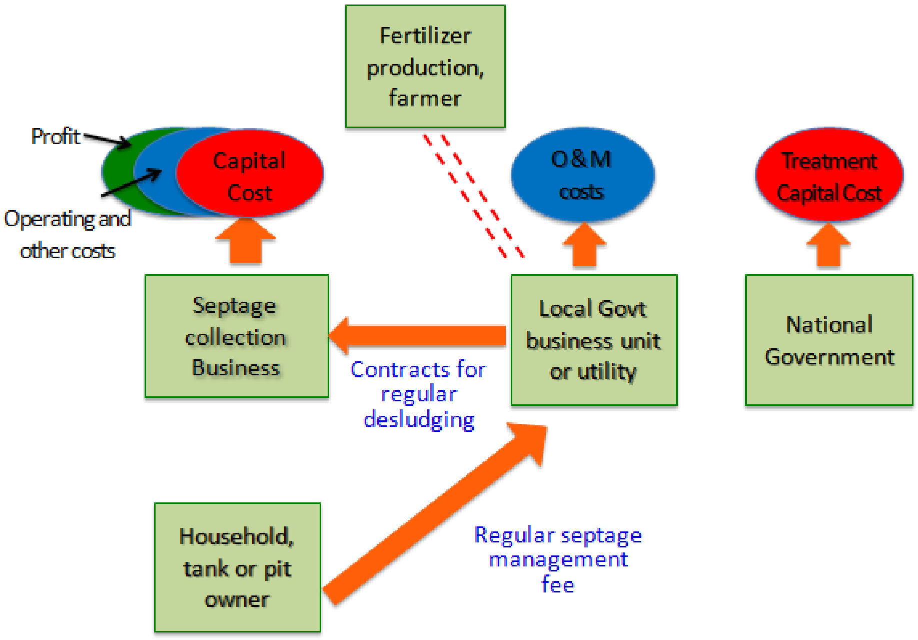

Figure 5: Financial flows for regular payment and regular emptying

Before implementing this option, the city would have to survey and record all pits and tanks, develop a desludging programme on the basis of these records, ensure that all tanks and pits have easily removable covers and manage desludging operations as well as the IPLT.
This brief review of the options for financing sludge management operations highlights the need for improved management capacity, particularly for systems that aim to finance on-call or regular pit emptying through regular charges levied on all households. These will require management of the activities of private sector sludge removal and transport contractors, which will no longer be entering into simple contracts with individual households but will be contracted directly to the responsible authority through a

more formal and administratively burdensome process. With this in mind, we now turn to possible improved management options.

MANAGEMENT OPTIONS

As already noted, direct management by municipalities and their business units have proved to be unsatisfactory, providing weak management and few incentives to deliver better services. One weakness of both direct municipal management and the UPDT option is the inability to keep septage treatment facilities finances separate from those of the municipality as a whole. This weakness could be overcome by allocating responsibility for the treatment operation to either a Regional General Services Technical Agency (*Badan Layanan Umum Daerah* or BLUD) or a Local Government Company (*Perusahaan Daerah* or PD). Both these options offer more management autonomy and allow the accounting systems for treatment to be separated from those of the municipality. The Regional General Services Technical Agency or a Local Government Company could provide sludge removal and transport services itself, engage private sector operators on contract to provide those services or restrict itself to providing oversight of private sector operations.

The private sector might be involved in treatment facility operation through either a management or a lease contract. The management contract option is simpler and more attractive to firms with limited experience of managing similar facilities, which would initially be the case for almost all firms. As firms gain experience, the option of implementing a lease contract might be considered. In this scenario, contractors would bid to operate the IPLT on the basis that they would be responsible for selling treated sludge and would keep any profit that they made from sales.

Private sector operators could be hired on service contracts to provide a sludge collection and transport service on behalf of the municipality or IPLT operator rather than offering a service in parallel to the municipality's own service. This would tend to formalize the involvement of the private sector contractors, something that is arguably desirable in the medium to longer term whichever option is adopted.

A STRATEGY AND PROGRAM FOR ACTION

A strategy to move from the current situation to one that more closely approximates to the ideal sanitation cycle would involve initiatives to:

(a) increase the amount of sludge removed from pits and tanks;
(b) ensure that the sludge is taken to the treatment facility rather than dumped or sold without treatment to farmers;
(c) ensure that the septage treatment facility is operated in a way that ensures that treated sludge is safe for use in agriculture and
(d) develop systems for marketing treated sludge

These initiatives would have be incorporated into an action program that (a) links action to available resources and (b) recognises the different time scales required to complete different actions.

Increasing the proportion of sludge transported to the treatment facility should be the immediate priority. This will require better management, starting with improved record keeping, and enforcement of legislation prohibiting indiscriminate dumping of faecal sludge. However, the key to success is likely to lie in a move away from charging for sludge deliveries to the facility. If this is also linked to increasing formalisation by requiring an operating permit in exchange for compliance it would provide the sludge removal and transport contractors with an incentive not to dump illegally.

The sanction for non-compliance could be removal of the permit, a fine or re-imposition of disposal charges. The last, however, is likely to be counter-productive.

The financial impact of removing septage delivery charges will be fairly limited but still leaves the septage facility operating at a loss. In the medium to longer term, options for financing desludging and sludge treatment operations through regular charges on all householders must be considered. Given its relative institutional simplicity, the option of introducing charges to cover the operation of treatment facility only, leaving charges for tank emptying to be levied by desludging operators, both public and private, may be the best short and medium-term option.

As management capacity develops and better information on the location and size of pits and tanks becomes available, the extension of regular charges to cover tank emptying can be considered. It is unlikely that the required development in management capacity can be achieved through the current municipal management and UPTD management models and so alternative management models need to be explored, as summarised in this paper. While doing so, the possibility of using some form of lease contract or agreement to encourage IPLT operators to sell treated sludge as a soil conditioner/fertilizer can be explored.

Increasing the amount of sludge removed from pits requires a number of linked actions, which will take time to achieve results but can be started immediately. Existing legislation must be assessed, amended as necessary and implemented in order to ensure that (a) sanctions on indiscriminate sludge dumping are available and used and (b) all new pits have openings in inside walls to allow exfiltration of excess water and removable covers to allow desludging. Proper provision for seepage will allow the gradual phasing out of the connections between pits and surface water bodies, so reducing surface water pollution and creating a need for regular tank desludging. Legislation to make such connections will speed up the process of change but should only be introduced when there is a good prospect that it can be enforced.

Efforts to market treated sludge should also be preceded by action to develop a context that is conducive to sales of treated sludge. This will include making farmers and consumers aware of the health hazards associated with the using untreated sludge as a soil conditioner/fertilizer and to improve IPLT management systems. This has a lower priority than other actions but should be part of the overall strategy.

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