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SOS – Management of Sludges from On-Site Sanitation

Towards More Sustainable Faecal Sludge Management Through Innovative Financing

Selected Money Flow Options

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Foreword

The Department of Water and Sanitation in Developing Countries (SANDEC) of the Swiss Federal Institute for Environmental Science and Technology (EAWAG), conducts applied research projects on faecal sludge management in developing countries with local partners in West Africa, Thailand and Argentina. This research focuses on a rather new domain of low-cost faecal sludge treatment technologies, implementation and reuse of dewatered faecal sludge, economic aspects of faecal sludge management in general and treatment options in particular.

This document summarises faecal sludge management costs; i.e. from collection and treatment to reuse or disposal of dewatered faecal sludge. It offers selected money flow options on the basis of this cost information. Since various financial constraints (e.g. high emptying fees, dumping fees) contribute to inefficient faecal sludge management, new financial approaches are necessary to promote regular pit emptying, controlled faecal sludge dumping and cost recovery. This document addresses faecal sludge management planners and policy makers and urges them to develop an economic model, which would make faecal sludge management more sustainable.
The following documents were completed during an internship at SANDEC and belong to a collection of three interrelated reports on economic aspects of faecal sludge management:

- Economic Aspects of Low-cost Faecal Sludge Management – Estimated Collection, Haulage, Treatment, and Disposal/Reuse Costs
- *Towards More Sustainable Faecal Sludge Management Through Innovative Financing – Selected Money Flow Options (this document)*
- Economic Benefits of Improved Faecal Sludge Management – The Case of Diarrhoea Reduction

SANDEC would highly welcome your comments and suggestions on this topic. All these documents can be downloaded from SANDEC's homepage. Further questions can be addressed to:

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Contents

Glossary

Annualised capital cost	An amount paid annually to reimburse the borrowed capital and interests at the end of the depreciation period.
Biosolids	The solid fraction of faecal sludge (or sewage sludge) after dewatering (water content typically between 70 and 90% depending on treatment option). Hygienic biosolids (after storage) can be used in agriculture as soil conditioner.
Depreciation period	The borrowed capital and interests reimbursed at the end of the depreciation period. The depreciation period corresponds here to the service life of the installation.
Faecal sludge	Sludge removed from different on-site sanitation systems (e.g. septic tanks, bucket latrines, pit latrines, etc.).
Public toilet sludge	Sludges collected from unsewered public toilets (usually of higher consistency than septage and biochemically less stable).
Septage	Contents of septic tanks (usually comprising settled and floating solids as well as a liquid fraction).

Abbreviations and Acronyms

EAWAG	Swiss Federal Institute for Environmental Science & Technology
FS	Faecal sludge
FSM	Faecal sludge management
FSTP	Faecal sludge treatment plant
O+M	Operation and maintenance
SANDEC	Department of Water and Sanitation in Developing Countries (at EAWAG)
PE	Population Equivalent (in this document: 1 PE = 14 g TS/day per capita)
TS	Total solids
WSP	Waste stabilisation ponds

1 Economic aspects of current faecal sludge management

1.1 Costs and benefits of faecal sludge management

FSM costs: Investment and O+M costs of faecal sludge management are not only restricted to treatment, but also include collection, haulage, and further reuse or landfill disposal costs. According to STEINER (2002a), Table 1 contains a FSM cost estimate for Kumasi, a Ghanaian city of one million inhabitants. The values are based on annual costs, with annualised capital costs calculated at 5% interest rate and 15 years depreciation period. Vacuum trucks are used for collection and haulage of FS treated by settling and waste stabilisation ponds (200 m^3 daily capacity, the FSTP is constructed, but not commissioned yet). Dewatered FS is stored and reused, as it is an environmentally and economically more friendly disposal alternative than landfilling. Table 2 compares FSM costs with biosolids disposal instead of reuse.

Table 1: Faecal sludge management costs in Kumasi (according to STEINER 2002a).

Item	Costs per t TS [US$][1)]	Remark
FS collection:		
• Truck capital cost	17	Assumption: Treatment plant in the middle of circular collection area (ideal case) of 300,000 PE[1]
• FS truck haulage costs	11	
FS treatment:		Primary treatment by settling ponds, secondary treatment by facultative and maturation ponds, including biosolids post-storage, 200 m^3 FS daily capacity
• Investment costs	27	
• O+M costs	21	
Biosolids sale:		
• Transport to buyer	5	Assumed sales price of US$ 5 per m^3 biosolids; dewatered FS is mixed with 50% binder (e.g. sawdust)
• Revenue from sale	-15	
Sum	**66**	Total net costs per t TS, excluding land purchase and monitoring programme

[1)] Capital costs were annualised at 5% interest rate with 10 years depreciation period for the truck and 15 years for the treatment plant.

The treatment costs were determined on a real case-to-case basis. Collection and disposal costs were calculated on assumed figures based on the local context. It is not recommended to generalise such cost information within a country or even to apply it to other areas, as local conditions (e.g. labour costs, land prices, site conditions, haulage distances, plant scale, etc.) are decisive, and only scarce cost information is available on FSM. In Bangkok, FS collection and treatment by constructed wetlands, and WSP costs amount to approximately US$ 130 per t TS for an annual capacity of about 150 t

[1] Population Equivalent: 1 PE = 14 g TS per day and capita (according to HEINSS et al. 1998).

TS of FS, excluding disposal costs (HEINSS 1999). This difference is attributed to higher labour costs and to a considerably smaller treatment plant size.

FSM benefits: A direct cost reduction is possible if biosolids are sold as soil conditioner to farmers or private persons. No landfill disposal is thus necessary, however, extensive storage (several months) or composting is needed to render the biosolids hygienically safe for reuse in agriculture and for transport to the buyer. These additional costs are estimated at approximately US$ 12 per t TS (STEINER 2002a). If biosolids are sold at US$ 5 per m^3 (corresponding to about US$ 15 per t TS FS), the benefits amount to US$ 3 per t TS (US$ 15 –12), and landfill disposal savings to US$ 37. Hence, FSM costs with reuse of biosolids were estimated to drop to US$ 75 t TS compared to the traditional disposal of dewatered FS. The main problems for the limited compost/biosolids market reside in a lack of commercialisation and information on both sides (farmers and sellers).

In addition to the potential revenues from the sale of biosolids for the FS treatment plant operator, other benefits can be derived for the entire population. These include environmental and public health issues, since FSM reduces ground- and surface water contamination, as FS is no longer disposed of illegally, and minimises the risk of faeces-related diseases. Thus, a lower morbidity and mortality rate of the population signifies less health expenditures (medicine, health consultation) and, therefore, a higher productivity since the person does not fall ill.
These and other benefits of environmental intervention in the health sector are currently being evaluated by WHO. Based on WHO (2000) recommendations and data from HUTTON (2002), we could estimate the economic benefits from diarrhoea reduction in monetary terms as a result of an improved FSM. Identified and valued benefits were health cost savings (medicine, hospital stay), and averted productivity loss due to lower mortality and morbidity. According to STEINER (2002b), diarrhoea reduction would amount to approximately US$ 150 and US$ 140 per ton TS of FS for Ghana and Thailand, respectively. It is important to note that these figures have a significant level of uncertainty, both as regards the methodology and source data. They are therefore only valid for the assumptions and conditions described.

Environmental impacts and benefits from a reduction of FS-related diseases (e.g. nematode infections) other than diarrhoea have not been valued in monetary terms for reasons of uncertainty and lack of data, respectively.

It is difficult to integrate the economic benefits into the FSM costs, because environmental and health improvements are not easily countable in monetary term. Moreover, costs have to be covered by identifiable stakeholders. The health and environmental benefits favour the population as whole, and only partly those who have to cover the incurred costs. Thus, it is difficult to convince the authorities or to encourage a community-based initiative to invest in FSM, except for the collection of FS (see below).

Emptying costs for households: Collection and haulage costs of approximately US$ 30 per ton TS of FS, listed in the Table above, are assumed to be normally covered by the emptying fee, paid directly by the septic tank or latrine owner to the emptying workers during the emptying service. A typical emptying fee in a West African city amounts from 10,000 to 20,000 FCFA[2], depending on the emptying volume and corresponding to US$ 15 – 30. In Nam Dinh (Vietnam), the emptying fee for a septic tank amounts to 260,000 VND[3] (KLINGEL 2001), or to US$ 17. This amount often

[2] 670 FCFA = US$ 1 (2002).
[3] 15,000 Vietnamese Dong = US$ 1 (2001).

exceeds the financial means of most of the population. By assuming a septic tank volume of 5 m^3, an average TS content of 25 g/l and an emptying fee of US$ 15 per septic tank, the revenue from the emptying fee would rise to US$ 120 per ton TS, whereas the theoretical collection and haulage costs total US$ 30 per ton TS. At first, this seems to be an important difference and, thus, presents a potentially significant source of income for the emptying company. However, practical and theoretical differences have been observed:

- Trucks frequently do not run at full capacity (many breakdowns, competition).
- Distance to dumping site is often much longer than theoretically assumed.
- Entrepreneurial overheads, such as licence procurement, fines and bribes – not included in theory – may represent an important cost factor.

Due to major discrepancies between theoretical collection/haulage costs and emptying fee, investigation should be conducted to determine the real economic costs.

Summary: Table 2 contains the global costs and benefits of FSM from an integrated viewpoint; i.e., irrespective of beneficiaries or payers. We neglected efforts and associated costs for support and promotion or reforms at government level. The results in Table 2, graphically illustrated in Figure 1, are classified into costs and benefits, and related to payers and beneficiaries, respectively.

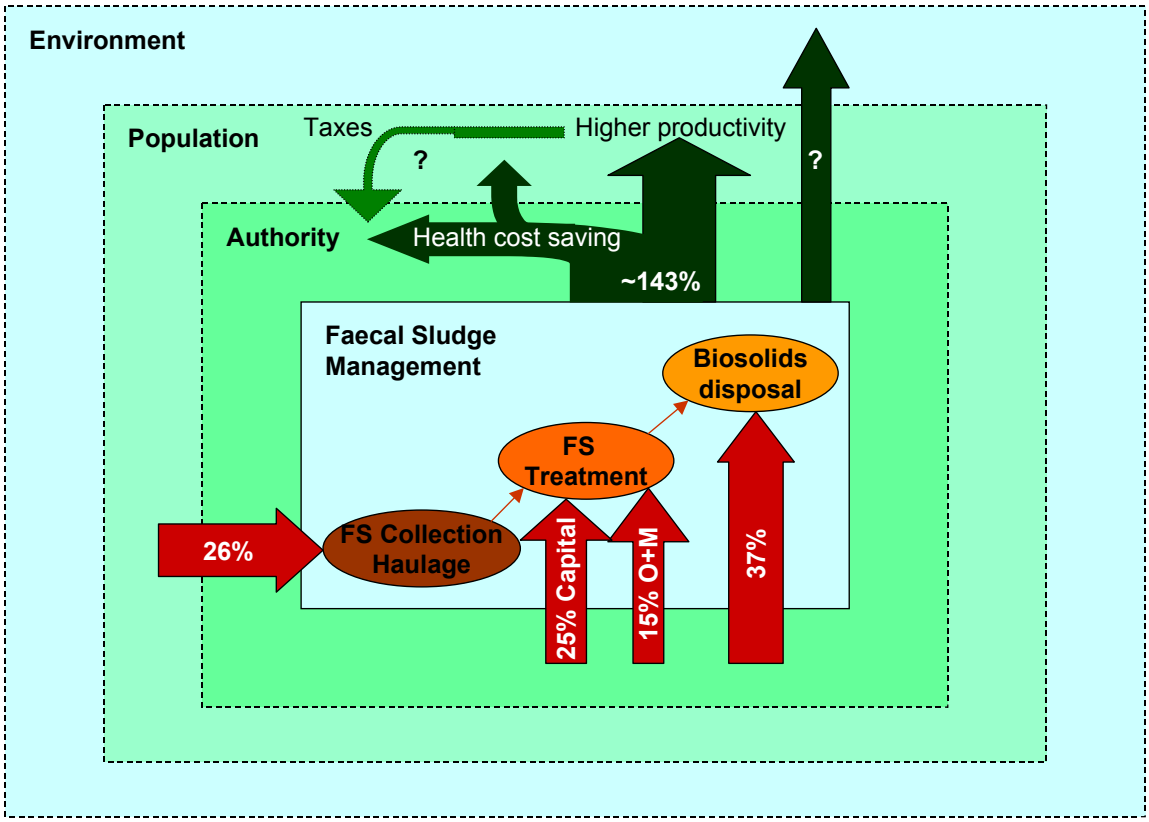

Figure 1: Costs and benefits of faecal sludge management. Red and green arrows distinguish between costs and benefits, respectively. The percentage of benefits refers to total costs.

Table 2: Summary of global FSM costs and benefits, including payers/beneficiaries. The treatment costs are based on a faecal sludge treatment plant comprising settling

and waste stabilisation ponds in Kumasi (Ghana). Other costs and benefits are estimates based on several assumptions, but still related to a Ghanaian context (according to STEINER 2002a and 2002b).

	Item	Payers / Beneficiaries	Amount [US$/t TS]
Costs	**FS collection**		
	• Truck capital costs	Vacuum truck entrepreneur paid by households	17
	• Haulage of FS	Vacuum truck entrepreneur paid by households	11
	FS treatment		
	• Capital costs	Municipality, (developing agency), possibly drinking water fee	27
	• O+M costs	Municipality, possibly contribution of vacuum truck from dumping fee	16
	Biosolids disposal		
	• Landfill costs	Municipality	32
	• Transport to landfill	Municipality	5
Benefits	**Health impact of diarrhoea reduction**		
	• Averted treatment cost	Health sector and population	67
	• Averted illness and death	Population, treasury (more tax revenue)	88
	Environmental protection		
	• Averted groundwater and surface water contamination	Population, municipality, nature	Intangible
	• Less odours and eyesores	Population	Intangible

The FSM benefits present the following two main difficulties: First, the estimate in monetary terms is rather vague. Based on more conservative assumptions, the costs would amount to far less than double. Second, the benefits from treatment cost savings are dependent on the local health policy regulating their distribution to the households and authority. However, household benefits from reduced illness may also have an

indirect benefit for the authority, since higher population productivity generates higher tax revenues, and contributes to economic sustainability and growth.

1.2 Economic obstacles to improved FSM

Although money is scarce in developing countries, it is not the only reason for the ineffectiveness of some previous investments in faecal sludge management. Other economic issues may hinder an efficient FSM. Based on experienced situations, Table 3 indicates other economic constraints preventing effective faecal sludge management besides money scarcity. Improved FSM is dependent on the interaction of technical, institutional and socio-economic aspects. Hence, improvements are required on all levels and in a coordinated manner. As this document deals only with the economic aspects of FSM, kindly refer to STRAUSS and MONTANGERO (2002) for technical and institutional problems and potential solutions.

Table 3: Economic elements hindering faecal sludge management, their consequences and possible solutions.

Level	Hindering elements	Consequences	Possible solutions
Collection haulage	- High emptying fee - Long distance to "official" discharge site → high costs - Vacuum truck fee to dump in treatment plant - No fine for illegal FS dumping	- Emptying only when toilet is really full - Adopting cheaper manual emptying alternatives - Illegal FS dumping preferably near the emptying site	- Encourage households to empty regularly - Decentralised treatment - Remuneration of correctly dumped FS in treatment plant - Controls, fines, introduction of emptying licences in compliance with the rules
Treatment	- Lack of political will to invest in FSM - No funds are budgeted for O+M with available FSTP	- Indiscriminate dumping of untreated FS - Limited sustainability and efficiency of existing installations	- Supporting the importance of O+M on all levels - Raising the awareness of the benefits - Sanitation tax (e.g. on drinking water)
Biosolids sale	- No market for compost or biosolids - Community-based initiatives are hardly lucrative - Lack of government support for community-based initiatives	- Limited market for biosolids - Limited potential of additional revenue from biosolids sale	- Commercialisation of biosolids, supporting farmers - Field tests and demonstrations - Subsidising biosolids to increase the sales price and encourage private initiatives

1.3 Why economic improvements?

Faecal sludge management mainly aims at improving the current situation of indiscriminate environmental dumping of untreated FS in many developing cities, since

it constitutes an important health risk (excreta-related diseases). According to Table 3, economic reasons are also responsible for indiscriminate discharge of untreated FS. Therefore, two main targets are pursued as regards economic modifications of the current situation:

- Ensuring that collected faecal sludge ends up in the treatment plant by incentive and sanctioning measures.
- Encouraging regular and mechanical pit emptying by incentive measures to reduce emptying costs for households.

With appropriate incentive and sanctioning structures, several money flow models can be developed to improve finances and attain a more sustainable FSM. Sustainable sanitation may be achieved or enhanced only by applying these types of measures (STRAUSS et al. 2002). Note that financial and institutional issues are closely related. When discussing various money flow options in Chapter 2, the available institutional framework is assumed to allow commissioning of selected money flow models.

2 From current to innovative money flow options to enhance FSM sustainability

2.1 General issues

A large set of different money flow models can be developed as a function of several parameters. We decided to subdivide the models into two main groups: without and with financial government intervention (e.g. subsidies). However, even without financial intervention, a minimum intervention by local authorities will always be necessary to issue, control and enforce regulations. As this report focuses on money flows, policy-related issues to improve faecal sludge management are only discussed marginally. However, financial interventions by the authorities not only imply subsidising, but also redistribution measures.
Another main subdivision could be made as a function of the relationship between emptying company and FS treatment plant owner and operator[4] – the main actors responsible for FS management – as one private sanitation company is likely to be active in both fields such as in Bamako (JEULAND 2002). In this case, the emptying fee would be used to also finance FS treatment. However, this situation is only considered in Paragraph 2.2.2. For the other money flow options, two different companies conducting collection and treatment are assumed.

This chapter was inspired by the work of JEULAND (2002), who is currently working as a technical advisor for a community-based sanitation company planning to implement an FS treatment plant in Bamako.

To develop the various money flow models, the following assumptions were made:

- Pits and septic tanks are emptied mechanically by vacuum trucks.
- A faecal sludge treatment plant is available to allow production of biosolids safe for reuse and, hence, no FS landfilling is required. Irrigation with liquid effluent is not

[4] We assumed that treatment plant owner and operator are the same company. However, it is also possible that the authorities own the plant and contract a company to operate it.

possible due to its salt content, normally ranging beyond the plant's salt tolerance limit. Hence, treated FS is sold and not disposed of.

- The costs are derived from Paragraph 1.1 (except for the dumping fee) and expressed in US$ per t TS of raw FS. These are estimates based on the Ghanaian context and only valid for the assumed conditions (e.g. transport distance). Treatment costs are based on the settling ponds treatment scheme (associated with WSP for liquid polishing), situated in Kumasi (see STEINER 2002a). Land purchase costs are not included.
- The treatment plant treats an assumed sludge mixture of about 1:4 (public toilet sludge:septage). The assumed mean TS load of delivered FS amounts to 25 g TS/l.
- All the costs are expressed in US$/t TS and based on annual O+M costs and annualised capital costs.
- If there is a fee for FS delivery to a designated treatment site, about US$ 2 per truck load of 8 m^3 is assumed, or about US$ 10 per t TS (25 g TS/l). However, the fee is proportional to the volume discharged.
- An average sales price of US$ 5 per m^3 of biosolids is assumed. According to STEINER (2002a), a benefit of US$ 10 per t TS can be derived from the sale of biosolids (US$ 15/t TS sales revenue – US$ 5/t TS transport costs to farmer). Although this may currently appear to be a far too optimistic revenue, it is integrated in the money flow model, which will hopefully become reality in the near future.
- To convert the pit emptying costs expressed in US$ per t TS into an emptying fee per pit, the pit emptying costs per t TS have to be multiplied by the pit volume and its TS content (e.g. US$ 120 per t TS would correspond to US$ 15 for emptying of a 5 m^3 pit with a TS content of 0.025 kg/m^3 (120·5·0.025)).
- To convert a sanitation tax, expressed in US$ per t TS, into a per capita price, about 76 people are assumed to produce one t TS per year, since a daily contribution of 36 g TS per capita[5] is assumed for a 1:4 sludge mixture.
- Administration charges for a sanitation tax or a remuneration system are not considered.
- The money flow models include only pit owners as FS producers, however, they also comprise public toilets.

2.2 Without financial government intervention

2.2.1 Private collection companies and independent treatment operators require a dumping fee

Figure 2 illustrates a money flow model without government intervention, but with collection/haulage and treatment conducted by separate operators. Intervention of private emptying companies, paid on the spot by the household during operation, is common in many cities. However, there are, in the majority of the cases, no private FS treatment operators for lack of profitability. Considering the model without treatment plant operators would lead to a model corresponding to the current situation encountered in many developing countries where no treatment is available and untreated sludge is discharged in the environment.

[5] According to HEINSS et al. (1998), the daily per capita load amounts to 14 g TS, and to about 100 g TS if septic tanks and public toilets are used.

Alternatively, the treatment plant could be owned and operated (or contracted out) by the public authority, which normally levies a tax to cover treatment costs. Paragraph 2.3 illustrates the system with public FS treatment subsidies.

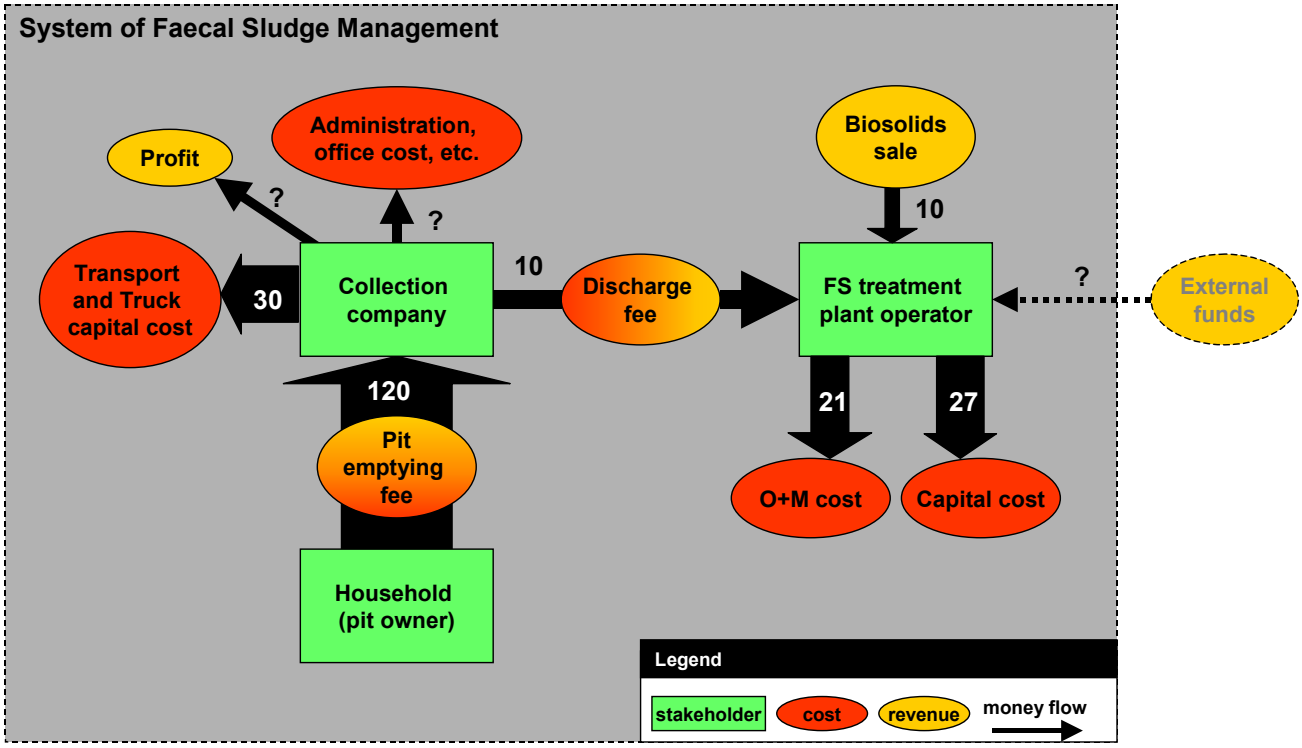

Figure 2: Money flow in US$ per ton TS of FS by independent collection/haulage companies and treatment operators.

Benefits/drawbacks: Hardly any benefits can be derived from this kind of financial FSM organisation, as several factors compromise its effectiveness. Looking at the money flow of the treatment plant operator, it is obvious that it requires financial support to cover the costs incurred. Discharge fees and revenues from the sale of biosolids hardly cover the capital and running costs. Without an intervention or redistribution from the authority, only external agencies could provide the financial support to cover the investment costs of treatment plants. Compared to the collection and haulage company, the discharge fee is the main drawback, as it does not motivate FS discharge at treatment plants. It is faster and cheaper to dump FS anywhere else, unless local authorities strictly control emptying companies, or if the treatment site is relatively close to the collection area.

Therefore, this money flow scheme is not recommended, as it favours indiscriminate dumping of untreated FS, and as the treatment plant cannot be sustained without external funds.

2.2.2 Collection and treatment conducted by the same operator

The concept of one community-based sanitation company, where one and the same company/entrepreneur carries out FS collection/haulage and FS treatment is currently

being studied in Bamako (Mali), as the company owns vacuum trucks and already conducts refuse collection. A FSTP is planned to treat collected FS and co-compost it with the organic fraction of collected solid waste after dewatering. According to JEULAND (2002), the role of the municipality is not clear yet. Therefore Figure 3 illustrates a possible economic model of FSM, without public intervention. If trucks other than those from the treatment plant operating company deliver to the plant, either a fee could be levied (with the problem of illicit dumping) or a remuneration could be demanded (plant operator pays to get FS from a third collection company). For clarity reasons, the latter option is not indicated in the figure.

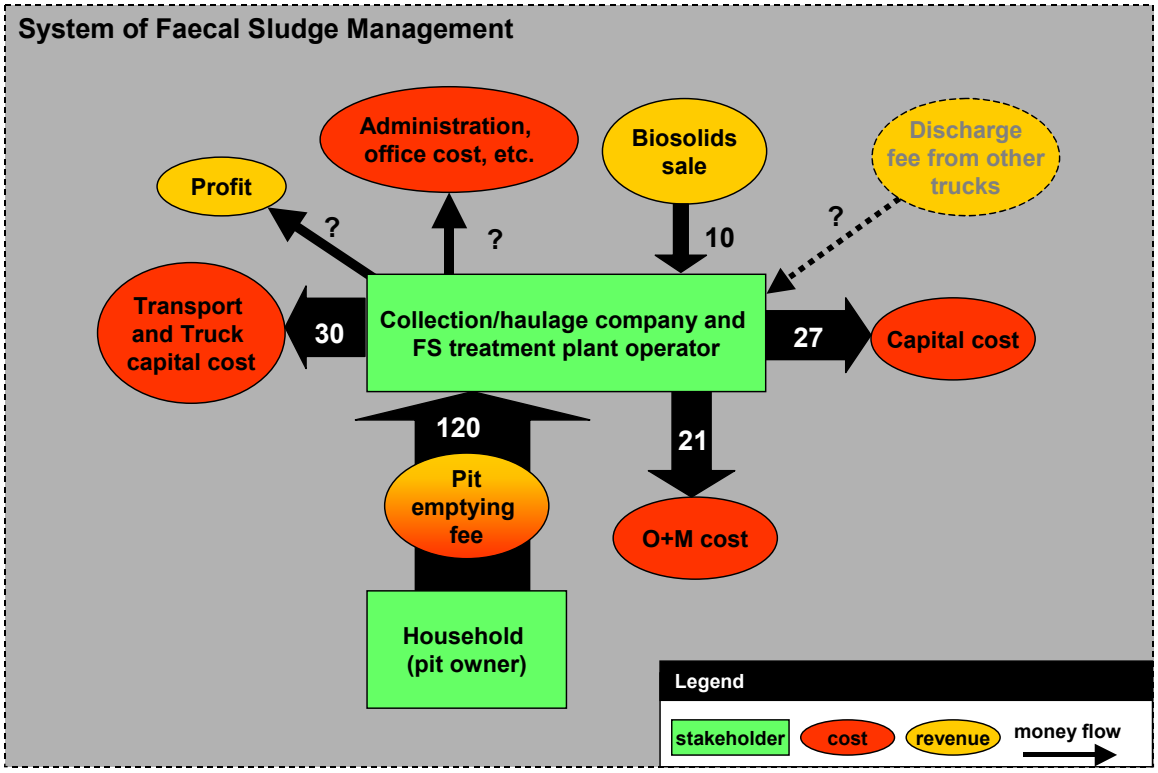

Figure 3: Money flow model with one sanitation company responsible for both collection and treatment plant operation.

Benefits/drawbacks: The main benefit derived is the financing of FS treatment by the collection fee and, hence, application of a financially viable FSM concept. Furthermore, indiscriminate dumping is no longer in the interest of the sanitation company, as the use of the treatment facility to produce saleable biosolids is favoured. The model is viable in theory, in practice, however, an emptying fee of US$ 120/t TS (~US$ 15 per pit) is not affordable by most of the households. In addition, this emptying fee does not seem to be sufficient to cover all the capital and running costs of the sanitation company, as FS transport costs may have been underestimated. In this case, the emptying fee may have to be increased to cover FS treatment and collection costs of the emptying operator. By raising the emptying fees, the sanitation company would no longer be competitive with other collection companies without treatment, and render pit emptying even less affordable for the pit owners.

High capital and running costs of FS treatment, and difficulties in commercialising biosolids at an appropriate price hinder entrepreneurial initiatives in the FS sector. It

would be different if a collaboration exists with external partners (NGOs, donor agencies, etc.), who could offer for instance the installation of the treatment plant.

2.3 With financial government intervention

2.3.1 Traditional approach: Households pay for emptying service

The approach is called traditional as the FS is considered by most stakeholders a worthless waste to be evacuated. The households usually have to pay quite a high fee for the emptying service (cf. Chapter 1.1). Emptying companies are either privately or publicly owned. An existing FS treatment plant is generally operated by the municipality and financed under this heading by donor agencies. Two different money flow models are presented below: a), FS treatment is financed by imposing a sanitation tax; b), authorities are subsidising FS treatment by selling licences

Model a): Authority subsidises FS treatment by a sanitation tax (or similar) and by levying a discharge fee (Figure 4)

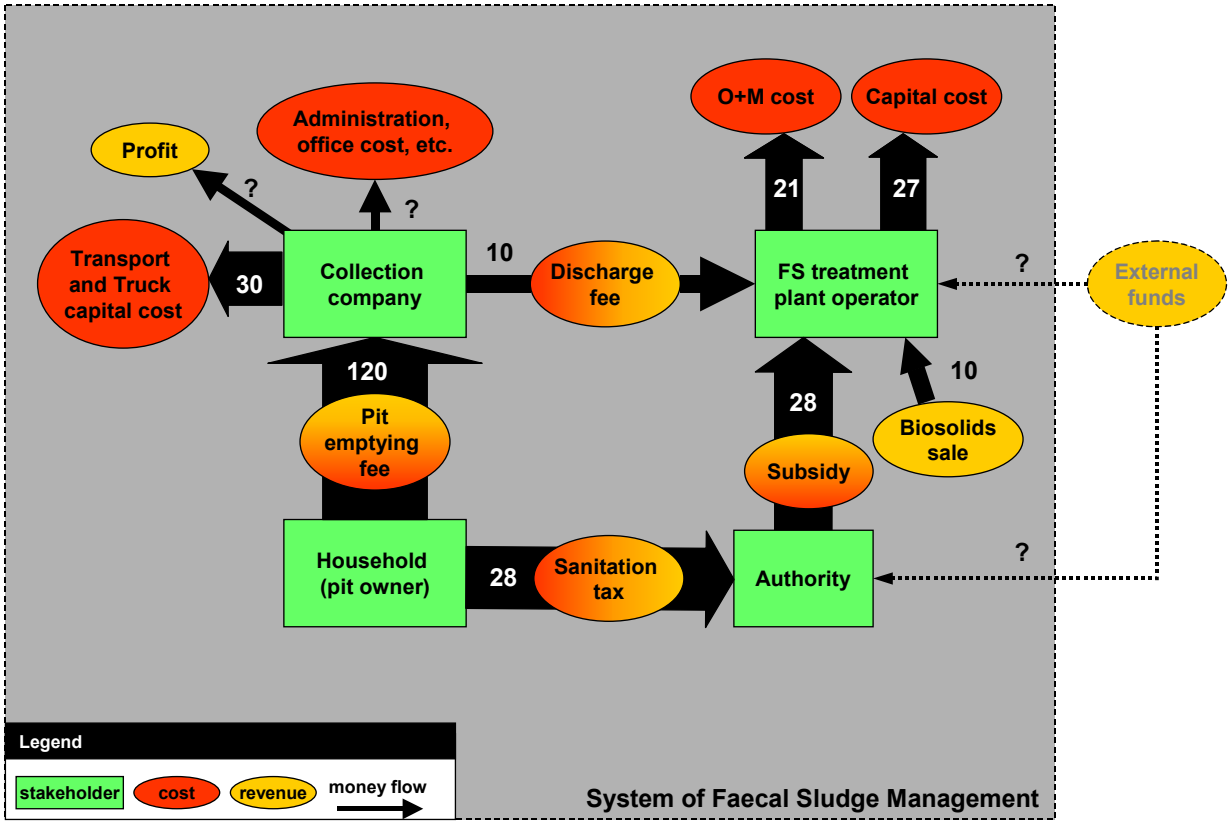

Figure 4: Subsidising FS treatment by a sanitation tax managed by the responsible authority

The aforementioned money flow models differ in the sense that the authority (central government or local municipality) subsidises FS treatment by a sanitation tax collected from the population or households. The sanitation tax could also be levied for instance via the water fee. FS treatment could also be subsidised without the levying of a sanitation tax, but by other funds (internal or external). Furthermore, the authority may demand a discharge fee for FS delivery from the FS treatment operator in order to cover treatment costs.

Benefits/drawbacks: The main benefit resides in the possibility to finance FS treatment by a sanitation tax instead of external funds. Nevertheless, major drawbacks prevail, as pit emptying fees remain high and the discharge/treatment fees encourage emptying companies to continue dumping FS indiscriminately. Emptying companies should therefore be controlled and penalised in the event of illegal dumping.

Since the introduction and application of a sanitation tax (type and amount) merit further discussion, it is described in detail in Chapter 3. The main problem resides in the correct allocation of the collected fees to the budgeted FS treatment.

Model b): Authority subsidising FS treatment by selling licences to FS collection enterprises (Figure 5)

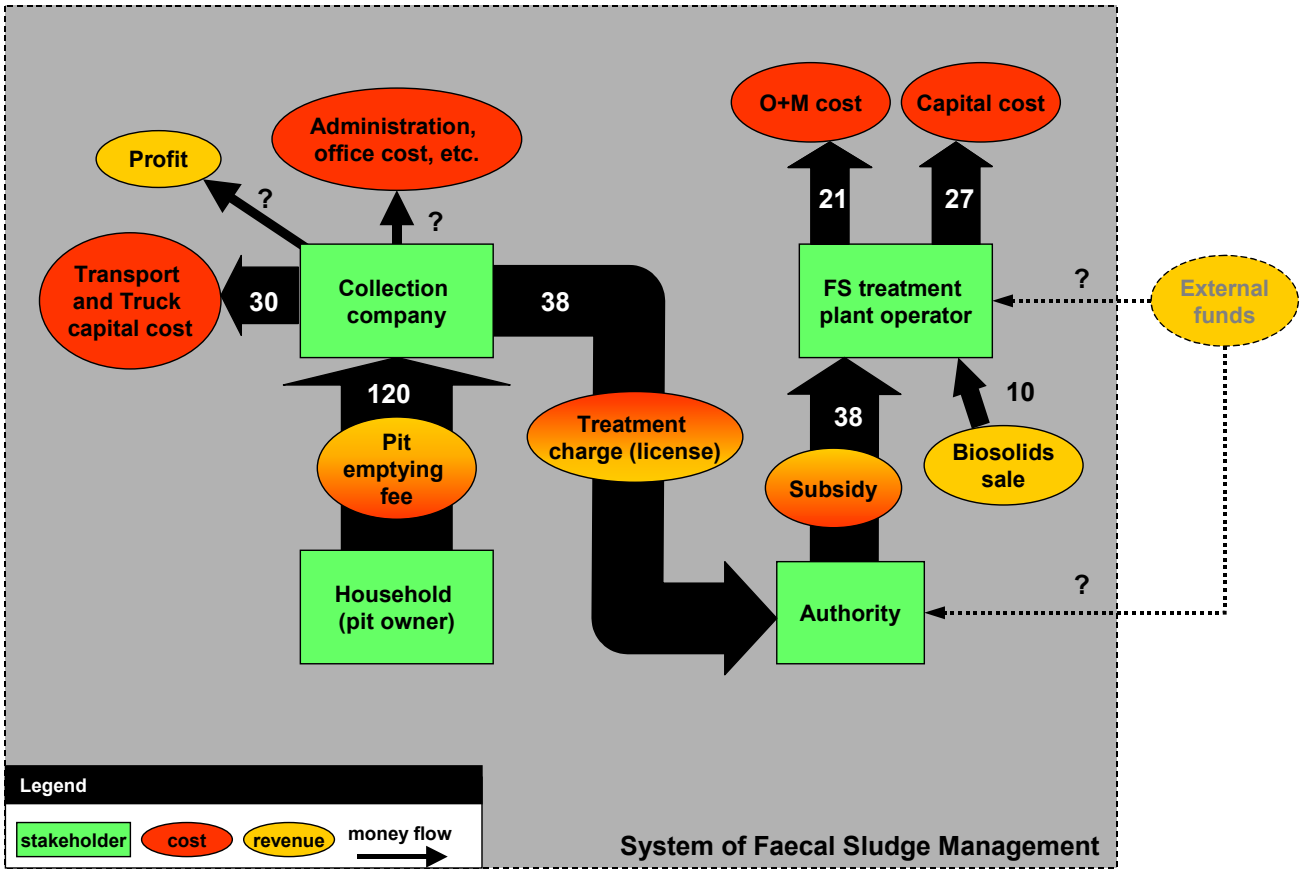

Figure 5: Subsidising FS treatment by a charge (licence) imposed on collection/haulage companies and managed by the responsible authority.

The specific feature of this model comprises the sale of collection licences (treatment charge). Only registered companies, paying a monthly or annual licence, are entitled to work as emptying companies. This treatment charge also authorises them to convey cost-free the collected FS to the treatment plant. The main purpose of this kind of charge is to control the emptying companies, to incite them to discharge the FS at the designated place and, finally, to finance FS treatment.

According to Barreiro (2002), this kind of dumping licence has recently been introduced in Danang (Vietnam), where a monthly tipping charge of about US$ 27 per vacuum truck operator allows unlimited delivery to the official landfill site.

Benefits/drawbacks: Licensed emptying companies must be controlled and penalised if necessary (e.g. in the event of uncontrolled raw FS dumping). This should offer an incentive for the emptying companies to collaborate with the authorities and the FS treatment plant. Once the collection licence is acquired, pit emptying companies deliver the highest possible load to the FSTP, as discharge has been paid for and in order not to lose the licence. Furthermore, the sale of the licence could cover the FS treatment costs according to the *"the polluter pays"* principle*,* as the money is indirectly provided by the households who have their pits emptied by a licensed operator.
Nevertheless, unauthorised disposal is still possible, as collection companies may want to save on haulage costs. Therefore, strict enforcement by the authority is necessary. Furthermore, if the sale of collection licences should cover the FS treatment costs, their price may be too high. According to Figure 5, the price of a licence is about one third of the pit emptying fee. In other words, an emptying company would have to pay more than US$ 6 to the authority per emptied pit to obtain the licence for an assumed pit emptying fee of about US$ 18. This fact may force the truck operator to raise his FS collection fees. Therefore, mechanical pit emptying by vacuum truck would be even less affordable for most of the population in developing countries.

The setting of the licence fee price is yet another difficulty. The fee price should in principle rise with the amount of collected FS. In practice, to maintain licence administration costs low, it is only possible to charge a single fee per truck (depending on its capacity) or operator, irrespective of the collected FS quantity. This would disadvantage small emptying companies whose trucks do not run at full capacity. Other funds (external, internal, sanitation tax, etc.) could reduce the licence fee price and, hence, mitigate an increase in emptying fees.

This model works quite well, as a direct discharge fee from the treatment plant site is no longer necessary, however, control of emptying companies and licensing procedure require considerable political will and enforcement capacity.

2.3.2 Innovative approach: FS is considered a precious resource

Since the money flow is reversed in this scenario, it is called incentive-based approach. The FS collection entrepreneur is remunerated when delivering his load to the official treatment plant. The capital and O+M costs of the treatment plant are subsidised by the authority. Two money flow models are shown hereafter. One model remunerates the emptying company and households for pit emptying and FS disposal; the other illustrates the possibility of remunerating FS delivery only.

Model c): Household and collection enterprise are remunerated for pit emptying (Figure 6)

The money flow model presented in Figure 6 is based on two incentive measures to prevent the two main economic drawbacks to a sustainable FSM scheme. First, the emptying company remunerates pit holders at the moment the emptying service is provided. This peculiar measure allows mechanical and safe emptying of all pits, irrespective of the financial situation of the pit holder. Second, remuneration for FS delivery to the FSTP by the emptying company allows the FS to be discharged appropriately.

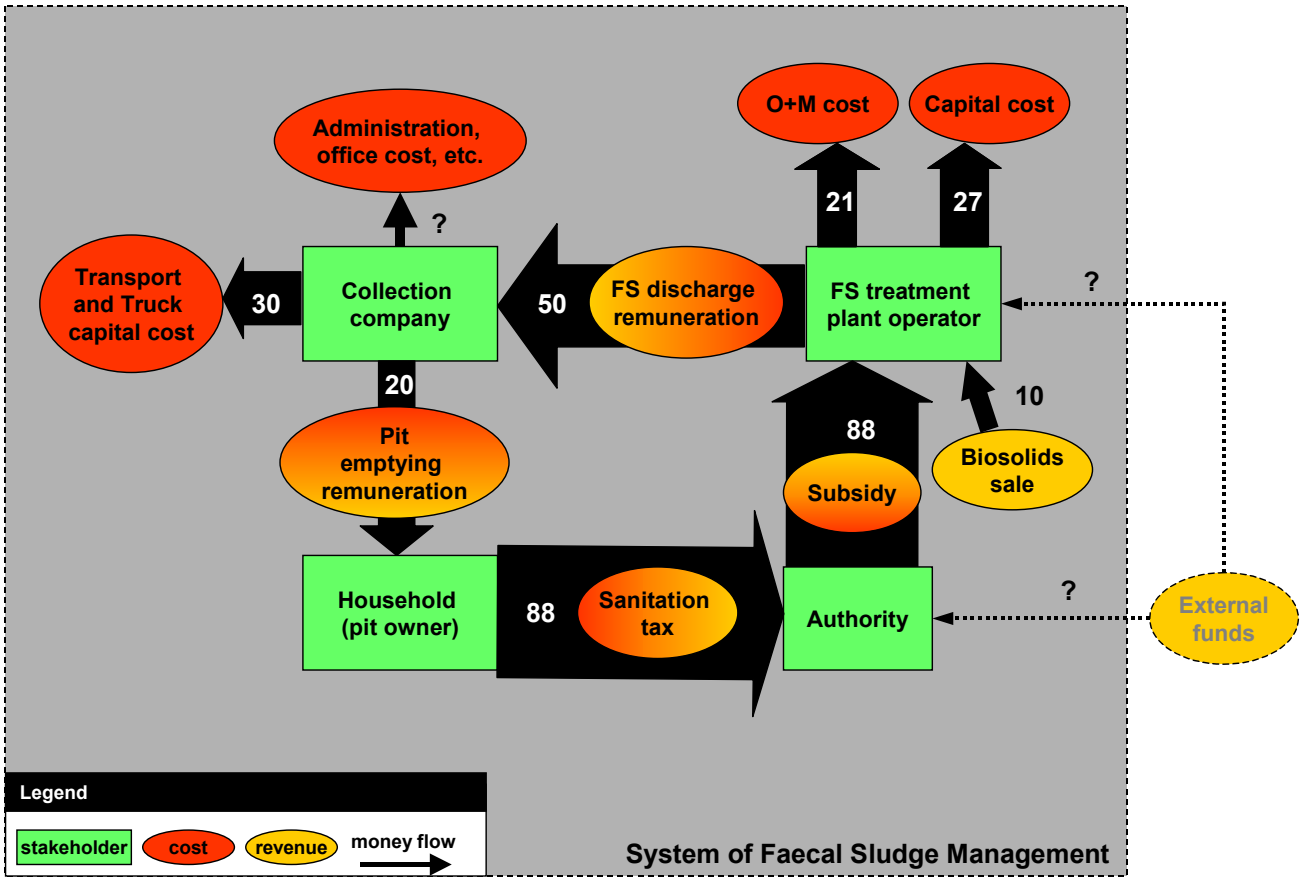

Figure 6: Emptying company and pit holders are remunerated for FS delivery. Remuneration and FS treatment are subsidised by the authority via a sanitation or similar tax.

Benefits/drawbacks: The aforementioned money flow model could present a sound solution to convey the FS to the treatment plant, as only a monetary incentive or compensation may prevent indiscriminate dumping of untreated FS. A "minimal" sanitation or FS collection tax could cover the FS treatment costs and the entire remuneration system.
However, the model is probably too incentive-oriented and, thus, rather prone to abuses within the context of poverty. Numerous possibilities could be devised to profit from the remuneration system: the pit owners may demand emptying before the pits and vaults have reached their useful or designed storage capacity, the emptying company fills up the trucks using river or drainage water before dumping the contents at the FSTP, or it refuses to remunerate the pit owner.

The sanitation tax would increase to about US$ 88 per t TS, corresponding to US$ 1.16 per capita and year[6]. This per capita contribution could rise depending on the sanitation system used (septic tank, public toilets, etc.), as a per capita TS load is much higher if public toilets are used instead of septic tanks. In addition, this tax could allow the covering of administrative charges. Chapter 3 contains more about taxes.

The proposed remuneration system appears to be an ideal approach to enhance sustainable FSM. This model is, however, likely to be prone to abuses and, hence, may

[6] Assuming a daily load of 36 g TS/per capita (sludge mixture 1:4), cf. Paragraph 2.1.

not function correctly. This could be offset by free pit emptying for the households via the collection company, who could in turn be remunerated at the treatment site.

Model d): Only the vacuum truck is remunerated for FS dumping (Figure 7)

The following model is similar to the last one except that the pit owner remuneration idea is given up in favour of a "modest" emptying fee. The emptying fee should be affordable by the population (e.g. US$ 20 per t TS, as indicated in the model, corresponds to US$ 2 for a septic tank of 4 m^3 and a mean load of 25 g TS/l), who would be encouraged to regularly revert to the emptying service. On the other hand, even if the emptying fee is low compared to current practice, it should motivate the emptying company to provide a dependable service. In return, the emptying company is remunerated once the FS is delivered to the treatment plant.

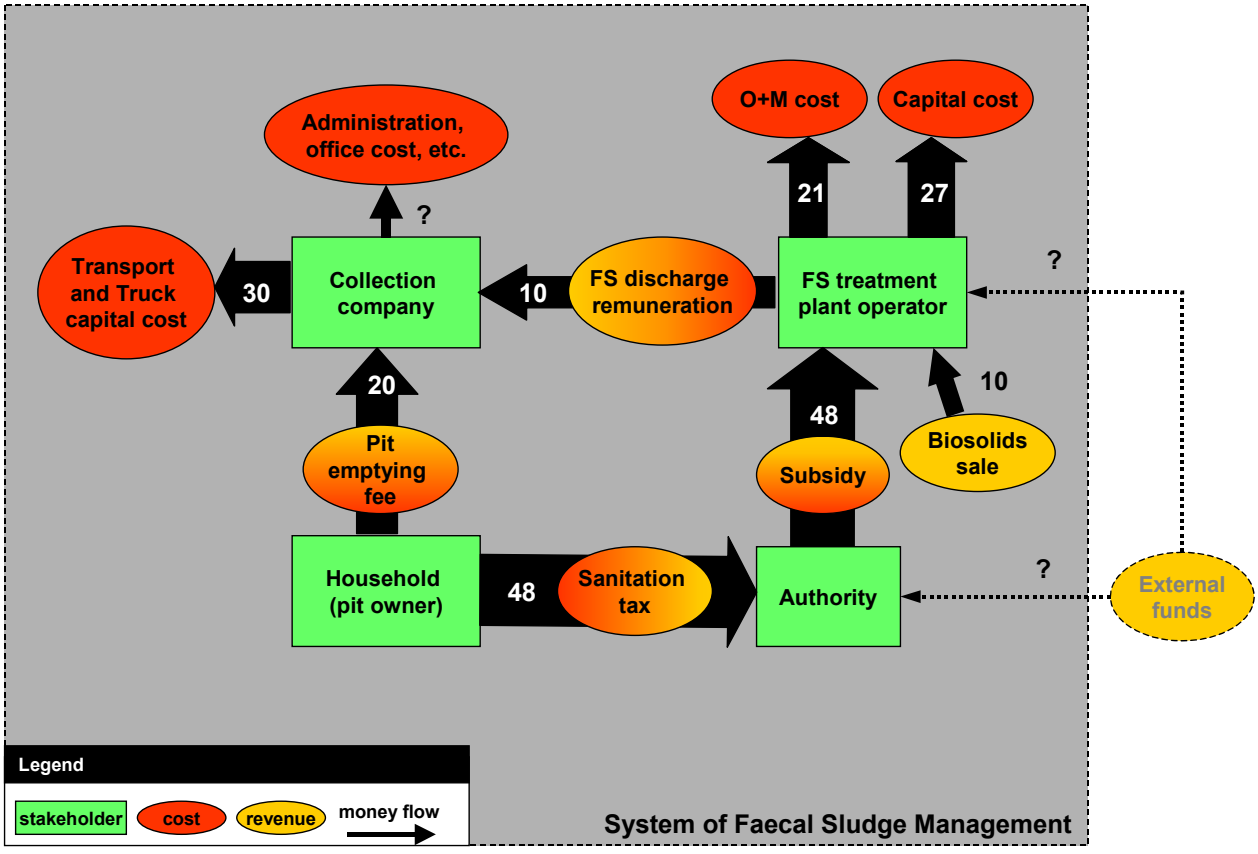

Figure 7: Emptying company is remunerated for FS delivery to the FSTP, while pit holders still pay an emptying fee.

Benefits/drawbacks: This innovative approach appears to be particularly appropriate for a sustainable FSM, as the collection company is forced to deliver the FS to the treatment plant to get remunerated.
The main challenge is the setting of a fair FS discharge remuneration to allow the collection company to cover its costs (in addition to the pit emptying fee). The higher the FS dumping remuneration, the more the pit emptying fee is reduced. However, a high FS dumping remuneration would encourage abuses, like filling the vacuum truck with river water. This explains the importance of a compromise between an appropriate FS dumping remuneration and an affordable pit emptying fee.

2.4 Innovative money flow model

Selected money flow models have been described, each presenting benefits and drawbacks. However, it is impossible to provide a panacea of models, as an ideal money flow system is highly dependent on local circumstances. An ideal case would probably be a combination of several incentive measures and subsidies by the responsible authority. Table 4 contains main reflections derived from the money flow options presented above, and provides useful inputs for FSM financing. Figure 8 completes the model graphically.

Table 4: Likely money flow solutions to current FSM problems

Current problem →	Possible solution approach →	Expected impact
- High pit emptying fees	- Reduction of the emptying fee by remunerating the collection company when delivering FS to the treatment plant	- Pit emptying becomes affordable for everyone - Emptying company is forced to deliver to the FSTP to be profitable
- Indiscriminate dumping of untreated FS	- Implementation of an FS dumping remuneration on the treatment plant or official FS dumping site - Control of emptying companies by the authority (e.g. via a licensing process)	- Incentive measure to get the FS where you want it - Possibility to control and penalise collection operators - Contribution to the FS treatment costs
- FS treatment requires external funds	- Implementation of a sanitation or similar tax (e.g. a surcharge on the water supply bill)	- Sustainable financing of FS treatment (capital and O+M costs)

As aforementioned, FS delivery remuneration should be set at an attractive level for collection operators to convey the FS to the treatment plant and to reduce pit emptying fees, but low enough to prevent abuses. The dumping remuneration level will depend on local conditions. It may not be necessary everywhere, as some cities use collection companies to dispose of the FS at an official site controlled by the municipality.

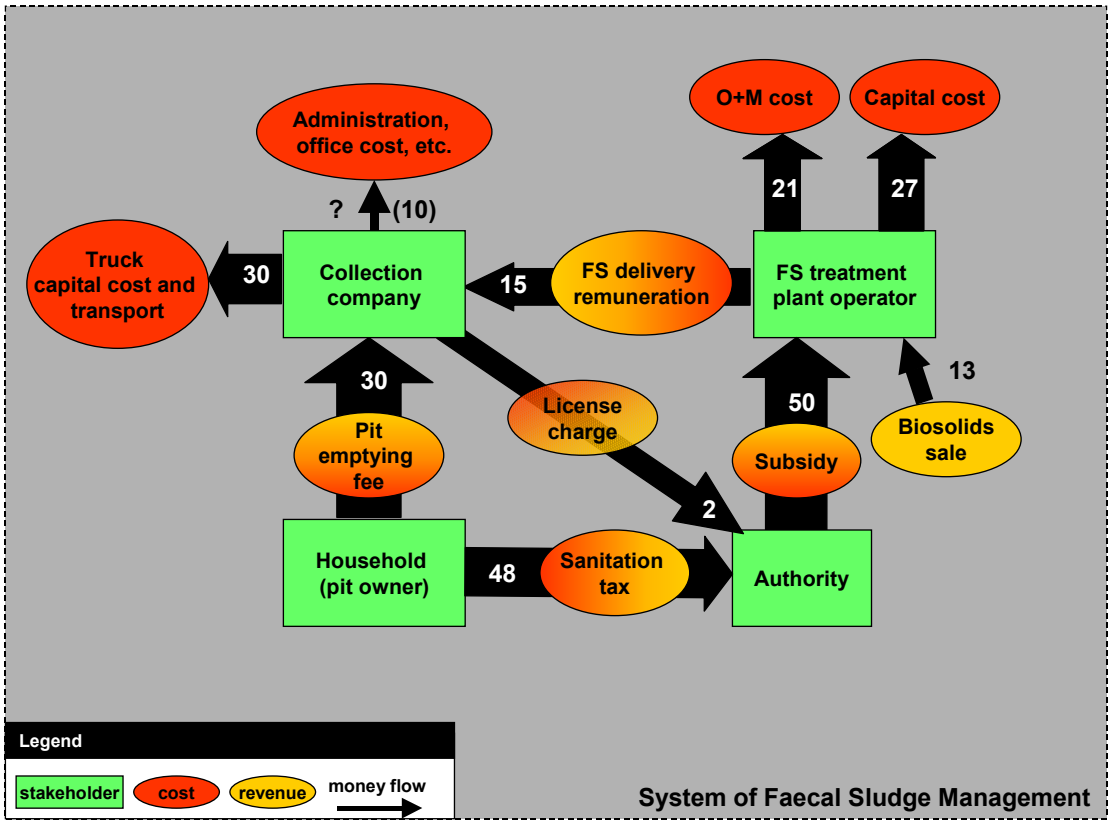

Figure 8: Innovative money flow model for sustainable FSM financing.

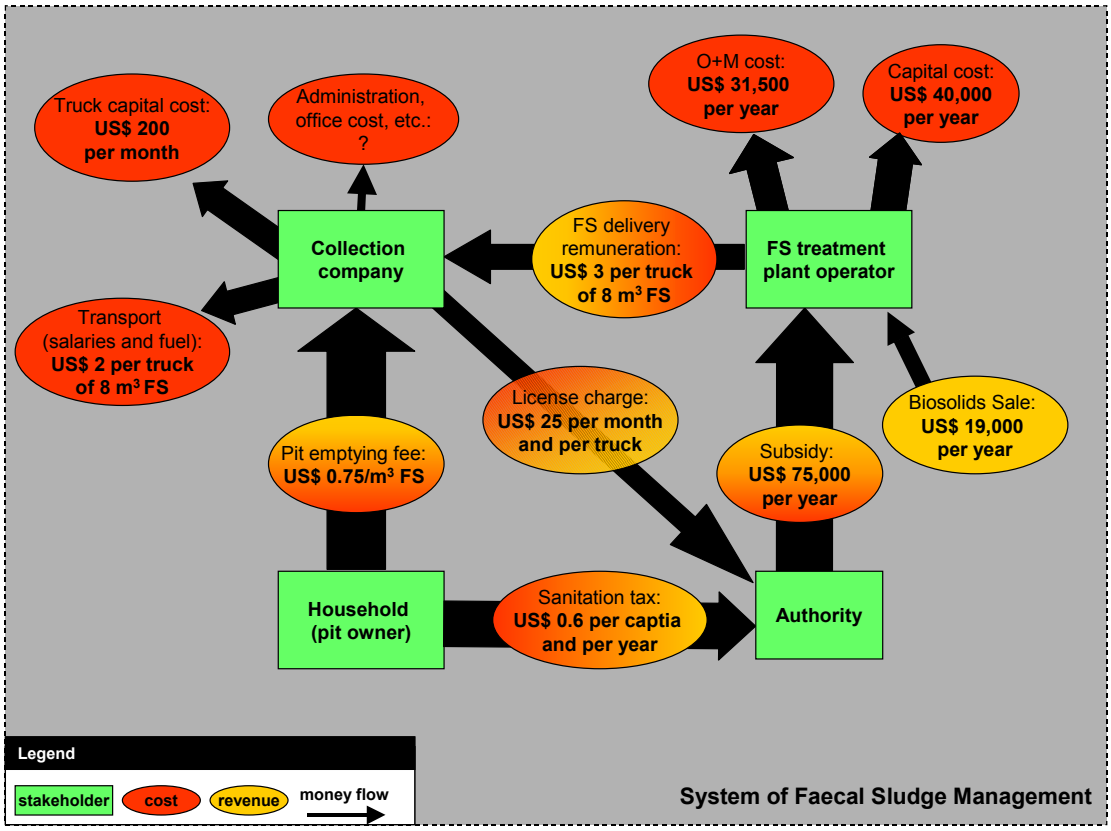

Figure 9: Innovative FSM money flow expressed in absolute values.

Figure 9 illustrates the innovative money flow model described in Figure 8 and expressed in comprehensive values (e.g. amount of emptying fee and absolute treatment costs). Refer to Paragraph 2.1 for calculation bases.

Implementation of a subsidising system is required to cover the FS treatment costs. Due to the large number of cash raising possibilities (sanitation tax, surcharge on water supply bill, etc.) and cost recovery options (determining the cash raising method), further information is provided in Chapter 3.

3 Subsidising FSM

3.1 Cash raising options for cost recovery

Chapter 2 recommends the introduction of a sanitation tax to subsidise FSM in general and FS treatment in particular. However, a sanitation tax merely constitutes one cash raising possibility. WHO (1994) suggests the following five main types of cash raising options to cover the costs of water supply and sanitation services:

- Community fund raising
- Indirect taxes (e.g. sanitation tax)
- Regular user charges
- Water vending
- Contributions in kind

As regards FSM, only indirect taxes and regular user charges are likely to be suitable (they are explained hereafter). Community fund raising (comprising ad hoc contributions, revolving funds, communal revenue levies and contribution of cooperative unions) are more appropriate for non-recurring investments where users benefit equally from the provision of the service, such as the construction of a water supply service. Furthermore, the community will not consider FS treatment as a real service, and, hence, will not be willing to pay for it.

Although water vending systems are often illegal, they have been formalised as a means of supplementing or replacing piped water distribution systems. At water kiosks, water can be sold by the litre or by the type of container. The sale of small amounts of water may be lucrative, but would present an unfair approach to subsidising FSM, as the underprivileged in urban areas rely on this type of water supply. Water vending renders users accustomed to paying for each water purchase. Furthermore, piped connections offer a better service and are cheaper in the long run, but the initial connection costs are often not affordable (WHO 1994).

Contributions in kind are not possible for FSM, as the problem is not related to latrine or well construction for a small group of people, where individuals could contribute directly to their construction and O+M.

According to JEULAND (2002), a community-based approach is conceivable, if for instance the population pays a monthly solid waste collection fee to a sanitation company, who could also provide a pit emptying service. The waste collection fee could be increased to finance FS treatment and possibly collection (if the emptying fee

is too low to cover its costs). However, the main problem is the determination of an appropriate monthly charge affordable by most households.

Indirect taxes (sanitation tax): In communities with an adequate taxation base and effective tax collection, indirect taxes may be appropriate to contribute to construction and/or O+M costs. A so-called sanitation tax would belong to this category of cash raising. The sanitation tax could not only be used to cover FSM costs, but also for rainwater drainage, water supply, solid waste management, and wastewater management if necessary. As regards FSM, transfer of sufficient funds from the taxation agency (responsible authority) to the FSTP operator should be ensured. Since this is not always an easy task, it constitutes the main drawback, as the FSTP operator has no guarantee that he will receive the budgeted amount (collected by the sanitation tax) to run the treatment plant properly. This would deteriorate the entire FS management service ($\rightarrow$ no money for FS dumping remuneration $\rightarrow$ collection operator will be forced to raise pit emptying fees $\rightarrow$ indiscriminate FS dumping without incentive measure), even though people pay the full sanitation tax.

The following two main options are used to determine the level of the sanitation tax:

- If only FSM is paid by the sanitation tax, a municipal charge could be introduced, generally in the form of a per capita flat rate tax, based on the assumption of uniform per capita production of faecal sludge. Thus, everybody would pay the same amount, irrespective of revenue or sanitation system.
- Taxation can be water use-related, for instance a charge on houses or other types of property, depending for example on their size; i.e., higher rates for larger houses assuming that water use or FS production is more or less proportional to the size of the house. This option is interesting and fair if water supply is also supported by tax recovery. It would be also possible to tax households according to their sanitation system, as it is indirectly also water-related, and would allow to tax wealthy people (population with a modern WC) more than poor people (traditional latrine).

Billing and collection of a so-called sanitation tax are usually best managed by the relevant municipality or some other local government entity, as it would reduce administration costs by combining the levying of the sanitation tax with charges for other services, such as electricity or housing (WHO 1994).

Note that there is little incentive to use water wisely and reduce wastage, since the sanitation tax is not dependent on current consumption (important if the sanitation tax is also used to maintain for instance the water supply system).

Regular user charges: An easy way to cover the FSM costs could be a regular user charge related to the water supply. It would be possible for instances to add a sanitation charge on the water bill of the households served by a private water tap connection. According to WHO (1994), user charges can be:

- Fixed charges per connection, normally per month.
- Charges based on metered use, where total payment is dependent on the amount of water consumed.

Fixed charges for each private water tap connection would for instances be simple to administer, and make water consumption metering unnecessary. On the other hand, this approach would not encourage careful use of water, as the user pays the same

irrespective of the amount of water used. A variant of this system is one in which the fixed charge differs according to the number of users (e.g. number of people in the household with water taps).

Use of water metering[7] allows charges to be based on the volume of water actually used. The more water consumed, the higher the charges. As regards water supply or wastewater management, this option has clear advantages, as the charge can be cost-related, and offers incentives to avoid water wastage. However, although there is no direct relation between water consumption and faecal sludge production, this kind of socially-dependent regular user charge would be a simple way to collect the funds for FSM; i.e., the wealthier population with high water consumption pays for the poorer inhabitants without proper water tap connection. Note that a metered tax can be set at a fixed rate per supplied unit or at different rates for different levels of consumption or, again, according to the number of users.

It is important to note that public water tap posts should be excluded from a metered or fixed charge in order not to raise the water price for the disadvantaged population who use the public water posts.

In urban areas, where FSM is necessary, the existing water supply infrastructure readily allows application of regular user charges, by simply adding the charge (metered or fixed) to the water bill. According to Barreiro (2002), the city of Danang (Vietnam) recently authorised the water company to levy a surcharge equivalent to 10% of the water production costs. Septic tank emptying, cleaning and FS treatment are foreseen to be partially paid by the income of this surcharge.

3.2 Determination of the sanitation tax

This section aims at providing some sanitation tax examples to illustrate their order of magnitude; i.e., who has to pay how much? Depending on the FSM money flow model, the sanitation tax has to cover partly the faecal sludge management costs (collection, haulage, treatment, and disposal). It is possible to relate the sanitation tax to a financial or economic criterion. A financial criterion-based tax aims at covering all the actual FSM expenditures of the responsible municipality (subsidies to FS collection and treatment plant operators, respectively). An economic criterion-based tax should, however, cover the actual (theoretical) costs incurred to the country or municipality. The economic FSM costs would include for instance the sum of all the financial costs minus the monetary benefits (health sector savings, higher productivity of the population, averted pollution of surface or groundwater, etc.). As the health benefits, briefly described in Paragraph 1.1, do not generate immediate national revenues and uncertain benefits, it will probably be difficult to convince the authorities to cover only the economic costs of FSM. We therefore recommend a sanitation tax based on the financial criterion in order to cover the municipal expenditures (subsidies and administration costs) of FSM.

As mentioned in Paragraph 1.1, the total costs per t TS of raw FS range from US$ 66 (including sale of biosolids) to US$ 108 (landfill disposal instead of reuse). These prices include annualised capital costs and O+M costs of FS collection and treatment, but exclude land purchase costs. Calculation details and assumptions (e.g. transport distance, truck price, etc.) are given in Steiner (2002a).

[7] Attention should be paid to the fact that breakdowns of water meters are common in developing countries!

Example of a per capita flat rate tax: This is the simplest way to estimate and illustrate the level of a sanitation tax in form or an indirect tax, respectively. The following data and assumptions are used to calculate the per capita flat rate:

- The overall public financial costs of FSM amount to about US$ 75 per t TS of raw FS (US$ 50 for subsidies (cf. Figure 8) paid to the treatment plant operator and US$ 25 for administrative charges, respectively).
- About 76 persons produce one ton TS per year, as the daily TS load is equal to 36 g per capita (sludge mixture 1:4 = public toilet:septage, cf. Paragraph 2.1).

Thus the annual flat rate tax would amount to US$ 1.0 per capita (US$ 75/76 people) and could cover all the subsidies for a sustainable FSM without external funds. This amount seems to be low, but could increase if the cost recovery rate is low and if the daily TS load per capita is higher (e.g. more unsewered public toilets instead of septic tanks).

Example of a regular user charge on the water supply bill: Calculation of the level of the surcharge, based on the metered use to be added to the monthly water bill, is dependent on the local situation. Therefore, the following circumstances for a West African city were assumed to illustrate a reasonable increase in water price.

- As aforementioned, the public costs incurred amount to US$ 75 per t TS; 76 people produce annually one ton TS.
- Only private water taps (in the courtyard or in the house) are taxed and the same rate per m^3 is applied irrespective of the consumption level.
- 25% of the population are served by water taps.
- The mean tap water consumption amounts to 40 litres per day and capita[8].

Thus, the population producing one ton TS of FS per year uses about 275 m^3 water from the metered water taps (0.25·76 people·40 litres/d·365d). The required surcharge on the water bill for FSM cost recovery therefore amounts to US$ 0.3 per m^3 (US$ 75/275 m^3). This would correspond to a monthly FSM surcharge of about US$ 2.2 for a household comprising six people with a private water tap. According to KONÉ (2002), the water price in Ouagadougou totals about 400 FCFS per m^3 (~ US$ 0.66); hence, a surcharge of US$ 0.3 would represent a 50% increase in the initial water price, which could be too high to be accepted by the population.

Note that the surcharge value required per tap water volume-unit is only valid for the listed (assumed) conditions. However, a water bill surcharge has to be assessed in detail during FSM planning, and based on money flows and local circumstances.

4 Conclusions and recommendations

In the strict sense of the word, FS management refers to faecal sludge collection, if only private operators are active in the pit emptying field. Since high emptying fees for

[8] The overall water consumption is likely to be higher, as the well water is often used for washing.

pit owners and indiscriminate dumping of untreated FS are the consequences, new FSM financing models are necessary. Subsidies from the responsible authority (government, municipality) are required to finance FSM and implement an incentive-based money flow model.

We recommend reversing the conventional flow of money and introduce a remuneration to the emptying company for FS delivery to the treatment plant (or official disposal site). This should encourage pit owners to regularly make use of mechanical emptying services, as pit emptying fees would be reduced. With the dumping remuneration, FS would be disposed of appropriately, as the emptying operator would not make a profit only with the pit emptying fees. The FS treatment and dumping remuneration is subsidised by the responsible authority, which recovers these costs via a sanitation tax imposed on the population. The implementation of a sanitation tax has to be carefully planned and adapted to the local conditions in general, and to the institutional framework in particular. We recommend imposing of a per capita flat rate tax to be collected annually with other charges levied by the responsible authority. Another rather socially oriented option consists in adding a surcharge to the private water bill, which would make wealthier people partly pay for the poorer population (richer people have private water taps and consume more water).

Apart from the sanitation tax, the authority could introduce a licensing procedure for FS collection companies. This would allow, on the one hand, to contribute a small amount to the FSM costs and, on the other, to penalise emptying companies for breaking the rules established (unauthorised dumping, increase in pit emptying fees).

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