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LANDSCAPE ANALYSIS AND BUSINESS MODEL ASSESSMENT IN FECAL SLUDGE MANAGEMENT

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SNV

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List of Acronyms

ADB	Asian Development Bank
BMFG	Bill and Melinda Gates Foundation
CIBD	Construction Industry Development Board
DJB	Delhi Jal Board
DOE	Department of Environment (Malaysia)
DOSH	Department of Occupational Health and Safety (Malaysia)
DPWT	Provincial Department of Public Work and Transport
DWASA	Dhaka Water Supply and Sewerage Authority
FS	Fecal sludge
FS E&T	Fecal sludge emptying and transport
FSM	Fecal sludge management
FSTP	Fecal sludge treatment plant
HCMC	Ho Chi Minh City
HIES	Household Income and Expenditure Survey
HP SADCO	Hai Phong Sewerage and Drainage Company
IWK	Indah Water Konsortium (Malaysia)
IWK-KL	Indah Water Konsortium of Kuala Lumpur (Malaysia)
JICA	Japanese International Cooperation Agency
JMP	Joint Monitoring Program
KWASA	Khulna Water Supply and Sewerage Authority
MCD	Municipal Corporation Delhi
MIME	Ministry of Industry, Mines and Energy (Cambodia)
MoE	Ministry of Environment
MoF	Ministry of Finance
MoH	Ministry of Health
MoLMUP	Ministry of Land Management and Urban Planning (Cambodia)
MoUD	Ministry of Urban Development (india)
MoWRAM	Ministry of Water Resources and Meteorology (Cambodia)
MPI	Ministry of Planning and Investment (Cambodia)
MPWT	Ministry of Public Works and Transport
NA	not applicable
ND	no data
NUSP	National Urban Sanitation Policy (of India)
PPC	Provincial People's Committees (Vietnam)
PUSPACOM	Road transport department (Malaysia)
PV	pit volume
SPAN	National Water Services Commission (Malaysia)
ST	Septic tank
STP	Sewerage treatment plant
SV	septic tank volume
URENCO	Urban Environmental Company (in Vietnam)
VIP	Ventilated Improved Pit latrine
WASA	Water Supply and Sewerage Authority
WHO	World Health Organization
WSIA	Water Services Industry Act (Malaysia)
WSSCC	Water Supply and Sanitation Collaborative Council
WTP	Willingness to pay
WWTP	Waste water treatment plant

1 INTRODUCTION

1.1 BACKGROUND AND RATIONALE OF THE STUDY

The link between unsafe sanitation and disease is widely recognized and published, in particular its impact on child mortality and the global disease burden. Examples of diseases transmitted through water contaminated with human waste are diarrhea, cholera, dysentery, typhoid and hepatitis A. Poor hygiene, sanitation and unsafe drinking water together are responsible for 88% of diarrheal disease infections (WHO, 2011).

Progress made in urban sanitation appears positive. In South and Southeast Asia, 65% of the 788 million people living in urban areas, has access to improved sanitation and a further 16% use shared facilities. Improved sanitation, in the JMP definition, is defined as facilities that "ensure hygienic separation of human excreta from human contract" (JMP 2010)[1].

However this picture is too optimistic. Toilets alone do not ensure hygienic separation of human excreta from human contact. Several sources suggest that the vast majority of urban coverage in South and Southeast Asia is either stand-alone on-site sanitation or a combination of on-site/ off-site facilities. All these facilities need to be emptied, once again posing a risk of human contact with feces.

Moreover, the information suggests that very little of the human waste coming from on-site sanitation is treated, with most waste water discharged directly into the environment (See Box 1). This is not only an environmental problem, but also an equity problem. Rich and middle classes construct septic tanks, whilst people from poorer households engage in emptying, often manually, and often live near dumping sites or rely on contaminated water resources for their livelihoods.

Box 1: Snapshot on Asian FSM

The rapid assessment of septage management in Asia done for 7 countries by AECOM, Sandec, Eawag Usaid Eco-Asia in 2010[1], suggests that sewerage connections in urban areas range from 2.3%-40% (with exception of Malaysia). Furthermore, less than 14% of this sewage is treated and only 0-30% of human waste from septic tanks is treated (with the exception of Malaysia where 100% is treated). (source: USAID ECO-Asia, AECOM, Sandec, Eawag, January 2010)

ADB's sanitation databook (2009) on 27 cities in Asia, mentions that while 15 cities have central sewerage, 11 of those only cover <30% of city population and only 8 of the 15 have treatment facilities for sewarage. In 13 out of these 27 cities more than half of the population uses on-site sanitation solutions. It is also noted that 70% of waste water is discharged without treatment and that only 4 cities have treatment facilities for waste from septic tanks. For 23 cities, the databook has no data on septage production or desludging frequencies.

The potential market for fecal sludge emptying and transport services from on-site facilities is considerable in South and Southeast Asia, and the quality of these services is essential to ensure that the separation of human waste from human contact is maintained. However information about these services is extremely limited. Most of the emptying and transport services are provided by the small scale informal private sector, with little oversight or regulation and in many cases without access to appropriate treatment or disposal facilities.

Due to a lack of data and aspirations for sewerage systems, septic waste management has historically been neglected by policy makers and local authorities. However the decreasing quality of fresh water resources, as

[1] These include full or pour flush facilities connected to sewers, septic tanks, with pit, or VIPs, pit latrines with slab and composting latrines.

well as the health and the environmental hazards resulting from unregulated disposal of human waste are bringing these appalling facts to the forefront of urban policy making. The overall study – which includes analysis in 30 cities across 10 countries in Africa and Asia - aims to contribute to filling the information gap on fecal sludge emptying and transport services. This report is a meta-analysis of work conducted in the Asia region, and includes a critical analysis of methodologies, findings, and opportunities for improved service delivery.

1.2 OBJECTIVES OF THE STUDY

- Map the current urban FSM practices in the 5 study countries, identifying barriers related to product technology, financing mechanisms, regulatory support and business profitability
- Identify opportunities for product and business model innovation, and provide recommendations for optimizing sustainable business models in fecal sludge emptying and transport in the studied countries
- Identify organizations (public / private) that could be partners in implementation of these recommendations

1.3 MAIN RESEARCH QUESTIONS AND SCOPE OF THE STUDY

Though the study did not have a defined set of research questions, the questions below have been derived from the broader "scope of the work" document in order to enable the reader to understand the focus of the study and the questions it is trying to answer (BMFG 2011). Before going into these questions, it is important to clarify scope of the study.

Access to sanitation is a human right[2], which among other things implies that States have the primary responsibility to ensure the full realization of the right as duty bearers. Specifically in relation to sanitation, access should be safe, physically accessible, affordable and culturally sensitive. The delegation of the delivery of safe drinking water and sanitation services to a third party does not exempt the State from its human rights obligations to ensure access for all. Overall service delivery remains the responsibility of the State.

For this reason, in the context of sanitation, the sanitation service delivery model has the objective to ensure access for all as defined in each country's sanitation standards. Service delivery can be provided through a combination of different technologies and instruments, and within varying institutional arrangements of the sector.

The service delivery model for on-site sanitation includes all the activities to ensure safe, accessible, affordable and culturally sensitive access to sanitation for all. It spans the whole chain of activities, from awareness raising and construction up to treatment and re-use[3]. Fecal sludge management (FSM) is a part of that chain, from on-site collection/storage to treatment and re-use or disposal. Fecal sludge emptying and transport services are one segment of the fecal sludge management chain. (See Figure 1) Even though the country reports talk about the service delivery model, they generally refer to only this segment.

This study focuses on the fecal sludge emptying and transport services, but naturally touches upon other aspects of fecal sludge management and to a certain extent also upon aspects of the broader on-site sanitation

[2] On 30th September 2010 the UN Human Rights Council, responsible for mainstreaming human rights within the UN system, adopted a resolution affirming that water and sanitation are human rights under the International Covenant on Economic, Social and Cultural Rights.

[3] In fact it includes much more than that, as regulations, enforcement, the construction supply chain, the management and operation of treatment and disposal and so on, are all necessary activities to ensure access to sanitation for all.

service delivery model. Nevertheless, it should not be read as a study of the full on-site sanitation service delivery model.

In practice it has proven difficult to maintain clear boundaries of the scope of this study[4], not least because some of the FS emptiers also clear public sewers and drains, in some cases they are even paid by households to do so. In addition the various country reports do not include full situational analyses of sanitation services in their surveyed cities.

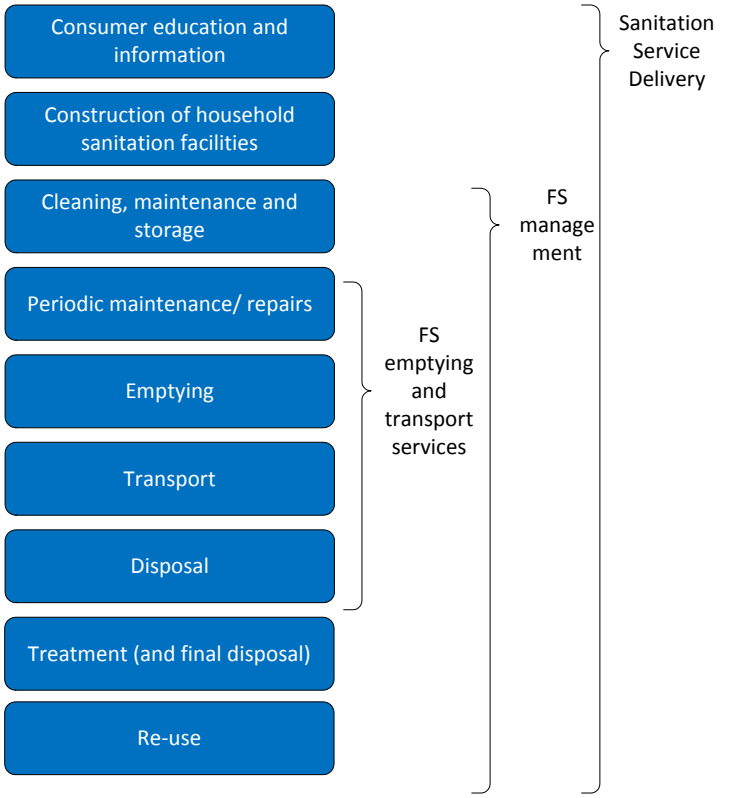


Figure 1 Components of the Sanitation Service Delivery Model

Important questions of the study were:

1. What is the size of the market for FS emptying and transport services in the different countries? (In absolute terms and as compared to the overall city population), both current and potential.
2. What are the strengths, weaknesses, risks and opportunities in the current FS emptying and transport business models?
3. To what extent is the current practice of FS emptying and transport sustainable? (financial, environmental, social)
4. What are the opportunities to establish a scalable sustainable FS emptying and transport businesses in the different countries?

1.4 SELECTED COUNTRIES AND CITIES IN THE STUDY

In Asia, the study was carried out in five countries: India, Bangladesh, Vietnam, Cambodia and Malaysia. In each country three cities have been studied: one capital city, a secondary city and a medium sized city. Out of the total of 15 cities in this study, there are 3 very large cities with over 6 million people (Delhi, Dhaka and Ho Chi Minh City), 6 relatively large cities with a population between 900,000 and 6 million people (Hanoi, Hai Phong, Kuala Lumpur, Phnom Penh, Khulna, Jaipur and Madurai) and 5 small cities with a population of less than 500,000 people (Melaka, Kuala Teranga, Siem Reap, Faridpur and Kampot - see Table 1.). The number of people per household in these cities ranges from 3.5 in Vietnam to 7 in India.

[4] In initial study country reports, the phrase "service delivery model" has sometimes been used to refer to the emptying and transport services only. Similarly "fecal sludge management (FSM)" has sometimes been used to refer to FS emptying and transport services only since this is the scope of the model being investigated in this study.

Table 1: Basic Demographic Data of Surveyed Countries

country	city	total pop (people)	total pop (hh)	annual growth rate
Bangladesh	Metro Dhaka	15,018,594	3,337,470	1.34%
India	Delhi (MCD)	10,204,284	1,700,714	4.60%
Vietnam	HCMC	7,396,500	1,946,447	3.6%
India	Madurai	3,560,000	508,571	1.84%
Vietnam	Hanoi	2,300,000	605,263	4.2%
Bangladesh	Khulna	1,728,760	384,169	1.34%
Malaysia	Kuala Lumpur	1,627,200	436,900	2.2%
Cambodia	Phnom Penh	1,327,615	270,942	1.70%
India	Jaipur	1,121,043	224,209	2.69%
Vietnam	Hai Phong	839,800	251,136	4.2%
Malaysia	Melaka	483,700	122,600	2.2%
Malaysia	Kuala T	337,000	69,700	2.2%
Cambodia	Siem Reap	168,662	34,421	1.70%
Bangladesh	Faridpur	135,837	25,342	1.34%
Cambodia	Kampot	38,819	7,922	1.70%

Figure 2: Location Map of Survey Cities

1.5 ORGANIZATION OF THE STUDY

The study was conducted during the period May –October 2011, undertaken by five different country teams:

- Bangladesh: WaterAid Bangladesh
- India: The Right Angle
- Cambodia: GRET
- Vietnam: Hanoi University of Civil Engineering
- Malaysia: Ere consulting group and Indah Water Konsortium

This Asia synthesis report has been prepared by SNV Netherlands Development Organization for the Bill and Melinda Gates Foundation. A similar set of studies has been carried out in 5 countries of Africa. Responsibility for the overall coordination and steering of the study lies with the Gates Foundation Global Coordinator, Sangeeta Chowdhry.

The tools and analytical framework provided for the Asia study were originally developed for the Africa study. The tools included 1) household survey questionnaire, 2) interview guidance for interviewing the fecal sludge and transportation operators, fecal sludge re-users, municipal authorities, governmental agencies in charge of water supply, sanitation and environment protection 3) forms for the description of sanitation facilities, the process of fecal sludge extraction, dumping sites or treatment plants, activities of reuse 4) models of income statement for manual and mechanized service providers.

Each country has adjusted the tools to their country situation following the kick-off workshop held in Delhi in May 2011. Guidance was given to Country Teams for certain aspects of data analysis, in particular the financial analysis and the calculation of fecal sludge production, by email and through two weekly phone calls with the Global Coordinator. Preliminary results were shared at the interim workshop in Phnom Penh (August 2011) and some additional inputs for the financial analysis were provided. Unfortunately the overall time frame of the study allowed little space for the Asia country teams to adjust and harmonize tools, agree codification and data analysis.

2 METHODOLOGY AND LESSONS LEARNED

2.1 SECONDARY INFORMATION

All countries have reviewed secondary information, typically acts and regulations as well as statistical information. Existing studies on the subject of fecal sludge emptying and transport were not available.

2.2 DATA COLLECTION

2.2.1 SELECTION OF THE CITIES OF THE STUDY AND REPRESENTATIVENESS FOR THE COUNTRY SITUATION

All countries were required to select 3 cities: the capital city, a secondary city and a medium sized city. Clearly "capital city" requires no further explanation of criteria. In Table 2 below the considerations for selection by the different country teams are given.

Table 2: City Selection considerations

Country	Considerations for selection of study cities
India	The team used the 2002 World Bank ranking on access to sewerage per state as this also determines the existence of on-site facilities. One state was selected from each group: top ranking, medium ranking and poor ranking. Furthermore geographical spread and size was considered[5].
Bangladesh	Based on size and geographical spread.
Cambodia	The team categorized the total number of cities in Cambodia into three groups according to the number of inhabitants: • Capital city (1), with a total of 1,242,992 inhabitants • Medium-sized cities (5), with between 60,000-200,000 inhabitants • Small-sized cities (36), with between 5,000- 50,000 inhabitants One city was selected from each group, representing the other cities in that category, also considering geographical spread.
Vietnam	Selection of cities based on the diversity of business models for FS emptying and transport services as well as size.
Malaysia	Based on size and geographical spread.

2.2.2 HOUSEHOLD SURVEY

All countries undertook household surveys. The suggested sampling methodology for the household survey of the study was to randomly sample households from each ward in the city. This approach was followed in the relatively smaller cities of Bangladesh: Khulna and Faridpur. For other cities teams deviated from this methodology for various reasons.

Malaysia, having reliable records of every household with on-site facilities, was able to draw a random sample from the population with on-site facilities in each city based on the review of maps and IWK data. Care was taken to include a mix of residential and commercial premises.

[5] The India team found that only 4.5% of the total number of towns in India have underground sewerage (NIUA 2010). In other words a total number of 232 towns have underground sewerage, and there are 4,929 towns without underground sewerage. However data presented for the three selected cities suggest that only a limited number of households have septic tanks or pits, and that most are connected to either sewer or storm water drains. This raises questions as to how representative these cities are as other cities would likely have a greater prevalence of on-site facilities.

Cambodia used a transect method for sampling to capture the diversity amongst urban areas such as old city centres, recent housing and peripheral areas etc. The number of households surveyed was then based on the population density in each commune along the transect. Two transects were defined in the capital city and one in each of the medium sized cities.

Vietnam also deviated from the suggested random methodology by selecting only those households who have been living in their house for more than 10 years and thus, should have experience of using fecal sludge emptying services. Furthermore households were selected from inner-city wards and periphery. In Hanoi the survey was limited to the 14 quarters of the old city only. India also applied a form of purposive sampling, only selecting those areas without access to sewerage.

For the very large cities such as Dhaka, Delhi and HCMC, sampling from each ward was not practical. In addition to the size of the city, unreliable or unavailable population figures and the relatively high coverage of direct connections to sewers or drains meant that there were no basic data from which a representative random sample size could be determined. Therefore in Dhaka and Delhi, purposive sampling was used and areas with a high incidence of on-site sanitation facilities were selected. However determining the size of the survey population remained problematic and as a consequence the sample results cannot be extrapolated to the wider population of each city[6].

Table 3: Survey Population and Sample Size for Surveyed Cities, sorted by Country

city	total pop (hh)	survey pop (hh)	sample size (hh)	% survey pop of total population	representing
Delhi (MCD)	1,700,714	424,857	600	25%	Population using on-site facilities
Madurai	508,571	35,873	292	20%	Population using on-site facilities
Jaipur	224,209	101,714	300	16%	Population using on-site facilities
Metro Dhaka	3,337,470	ND	467	ND	unclear
Faridpur	384,169	384,169	358	100%	Whole city
Khulna	25,342	25,342	395	100%	Whole city
Phnom Penh	270,942	65,974	1320	24%	Whole city
Siem Reap	34,421	10,768	426	31%	Whole city
Kampot	7,922	5,137	308	65%	Whole city
Hanoi	605,263	489,362	400	ND	14 quarters in the old city of Hanoi
Hai Phong	251,136	232,760	300	ND	unclear
HCMC	1,946,447	1,540,938	300	ND	unclear
Kuala Lumpur	436,900	58,252	200	13%	Total population using on-site facilities.
Melaka	122,600	44,338	200	36%	
Kuala Terengganu	69,700	57,109	200	82%	

[6] An additional issue is that the country studies do not consistently provide any information on households who connect directly to storm or surface water drains rather than sewerage. From the perspective of health and environmental sustainability, these households should use pits or tanks, and therefore this group are potential customers of faecal sludge extraction services.

An additional issue encountered in Delhi and Dhaka was that some of the selected areas for the household surveys were unauthorized settlements or unrecognized colonies. This makes it difficult to compare the survey population to the total population of the city. Not only is the population of the survey area unknown, but it is also not clear to what extent this population has been included in the total population assessment of the city, or whether they need to be added to official city population figures. The sample size and survey population of each study city are given in Table 3.

From these country study experiences the following recommendations can be made for future household surveys:

- Where the population is relatively small and the percentage of households with on-site facilities is high, a transect methodology seems most appropriate and cost effective because it can be practically implemented and captures sufficient diversity.
- Where the percentage of households with on-site facilities is extremely low and there are reliable data available on these households, such as cities in Malaysia, the study could focus on the population with on-site facilities only.
- Where the percentage of households with on-site facilities is extremely low, the cities are huge or there are no data available, such as for Dhaka, the study should use a transect method of geographically defined areas (on a map if no natural borders exist) known to have high prevalence of on-site facilities. Population density in those areas can be estimated in order to estimate the total population in the area. Satellite images are a useful tool to assess the numbers of plots and their boundaries and are often readily available. Of course this approach takes more time than situations where all data are readily available and reliable. Ideally a transect would also be done of the whole city, in order to assess the variation between the areas that are thought to be 100% sewer or drainage connected.

Though the tools provided were for household surveys, strictly speaking the surveys should have included all types of premises because all are potential customers of fecal sludge extraction and transport services, i.e.: residential premises, commercial premises and institutions. Only Malaysia included commercial premises in their survey, Cambodia included a couple of interviews with owners of commercial premises and in Madurai the India team included government institutions. For HCMC the Vietnam team differentiated between houses and apartment buildings and included public toilets. For future surveys it is recommendable that surveys should include all premises that are potential FSM customers.

2.2.3 Sampling and data collection on fecal sludge emptying and transport businesses

All the countries conducted detailed interviews with FS emptying and transport businesses. All countries used a combination of “snowballing” and cross-checking with stakeholders as their methodology for identifying mechanical and manual emptying and transport businesses. Information was sought from the Municipal Corporation (Delhi) and the respective public authorities in Jaipur and Madurai and by asking households in Faridpur. In Vietnam the team asked the official company for the names of the service providers, since most of them are former employees. In Malaysia a list of registered businesses was consulted, but several of those had stopped operating so it was also an iterative process. As a result, sampling used a combination of purposive and opportunistic methods.

Due to the limited number of operators (except in some of the larger cities), most country teams interviewed all the identified mechanical emptiers. For Phnom Penh and Siem Reap, the Cambodia team selected a sample representing public and private emptiers as well as small and medium sized emptiers.

Manual emptiers exist in all countries except Malaysia, though in Vietnam there are very few, but it was sometimes difficult to identify them. Households do not like to say that they use manual emptying services and

many manual emptiers have multiple professions/ sources of income. In India and Bangladesh manual emptiers belong to a specific social group, but that does not mean that all people of that group are actually doing the work. Due to this difficulty in locating manual emptiers, no selection criteria were applied when sampling, and all those identified were interviewed.

Table 4: Businesses interviewed by City, sorted by Country

City	Total			interviewed			
	manual	mechanical	utilities	manual		mechanical	
Delhi (MCD)	1,085	35	1	15	1%	12	34%
Madurai	ND	29	1	ND		6	21%
Jaipur	ND	10	1	ND			0%
Metro Dhaka	ND	2	-	ND		2	100%
Faridpur	ND	-	1	ND		1	
Khulna	ND	-	1	ND		1	
Phnom Penh	24	19	1	5	21%	11	58%
Siem Reap	NA	6	1	NA		4	67%
Kampot	1	1	-	1	100%	1	100%
Hanoi	ND	50	1	ND		9	18%
Hai Phong	ND	15	1	ND		4	27%
HCMC	ND	61	1	ND		6	10%
Kuala Lumpur	NA	7	1	NA		5	71%
Melaka	NA	6	1	NA		4	67%
Kuala Terengganu	NA	-	1	NA		1	

Considering the various sampling methods applied, it is considered that for all cities the data collected can be viewed as representative for mechanical emptiers, but only for the Cambodian cities and Dhaka is the data considered representative for manual emptiers.

Data collection on emptying businesses was done via interviews and observation of their work and in India and Malaysia focus group discussions were held. In Malaysia an additional written questionnaire was used and Malaysia was the only country that surveyed the employees of emptying businesses. Data collection with emptying businesses is considered to be reliable and solid in all countries.

2.2.4 KEY STAKEHOLDERS IN FECAL SLUDGE MANAGEMENT

As would be expected, the key stakeholders in fecal sludge management in each country vary greatly. To investigate the specific institutional arrangement for each country in relation to FSM could be an independent study in itself. However, key aspects affecting FS emptying and transport services are essential to understand the market. As the individual country reports did not report on institutional arrangements to the same degree, Table 5 below gives an overview of the stakeholders that were identified based on the country reports alone.

Table 5: Key Stakeholders in FSM by Country

	India	Bangladesh	Vietnam	Cambodia	Malaysia
Federal authorities	x		x		x
State/ Provincial authorities	x		x	x	
Municipal authorities /City Corporations	x	x	x	x	x
Public Utilities		x	x	x	x
Operators of treatment plants and/or official dumping sites		x		x	
Urban development departments (local or national)	x				
Environmental or pollution control departments (local or national)	x	x			?
WSS line agency (local or national)					?
Ministry of Health			x		
Ministry of Public Works/ Infrastructure/ Construction					
Ministry of Environment and/or Water Resources	x	x			
Ministry responsible for Rural development					
Ministry responsible for Urban development				?	
Civil society groups					
NGOs involved in mechanical emptying		x			
International/ Bilateral donors (WB, ADB, AFD, Korean Cooperation, GIZ etc)		x	x	?	
UN Agencies			x		

For future studies it is recommended to approach stakeholder data collection in a more systematic way.

2.3 METHODS OF DATA ANALYSIS

2.3.1 SITUATIONAL ANALYSIS- LINK TO THE BIGGER PICTURE

The situational analysis reviewed analyzed the environment in which fecal sludge emptying and transport takes place. This identifies the population that requires emptying services as a function of the total population of each city, different sanitation solutions used in the cities, current rate of increase and future projections for sewerage connections, as well as the legal and institutional framework. It gives an understanding of the magnitude of the fecal sludge management challenge in each city and the relevance and appropriateness of the solutions we might propose in each city.

2.3.2 ACCESS TO DRINKING WATER

The coding guidance provided in the household questionnaire allowed disaggregation for the following categories: private connection, borehole, water kiosk, water vendors, well, surface water (river, pond), others. These were variously interpreted by the country teams and were not always applicable to their contexts. As a result, the countries have used different, very context-specific categories to describe access to water supply. For example Cambodia distinguishes specifically between public, private and self-supply while Bangladesh talks about hand wells.

From the perspective of the subject of the study there could be two main considerations for the classification of access to water supply:

- Alignment with the guiding international definitions (JMP) to enable easy understanding and interpretation.
- Classifications that facilitate analysis of the data. For example a classification that gives an indication of water consumption (in case grey water is discharged into the sanitation tanks/pits[7], and/or a classification that gives an indication of susceptibility to contamination by open drains etc.

For the purpose of consistent reporting, this document attempts to reinterpret the country data following the JMP definition of access to drinking water:

- Piped water on premises
- Other improved sources (public stand posts, tube wells, boreholes, protected dug wells, protected spring)
- Unimproved sources (unprotected dug well or spring, surface water, vendors)

2.3.3 SANITATION TECHNOLOGY AND SYSTEMS

The codification of sanitation technology is crucial for the interpretation of the results of the study. However, country teams have used different terminology and definitions of technology. One of the difficulties is that only in Vietnam and Malaysia are there standardized government-enforced designs. The main issue is that multiple interpretations and norms of technology options make it difficult to compare and contrast the country findings. There are 3 main aspects :

- Firstly, insufficient distinction is made for the various components of a toilet facility: the user interface, the collection and storage, etc.
- Secondly, the coding system does not capture the fact that categories on-site and off-site are not mutually exclusive in countries like Vietnam and Cambodia, because combinations of on-site facilities connected to small bore sewers or storm water drains exist.
- Thirdly, the current coding system does not allow us to distinguish between safe (sanitary) and unsafe systems.

Therefore to overcome these issues, this report attempts to reinterpret and codify sanitation technology following the definition of functional groups of the EAWAG-WSSCC Compendium of Sanitation Systems and Technologies (2009) and uses the diagrams in the Sanitation Technology Options Handbook of South Africa (2002) and some of the drawings from the Cambodia report to communicate the variations. It is felt that visualization of the different sanitation systems is necessary to ensure proper (common) understanding.

The EAWAG compendium groups technologies according to function into 5 groups:

- User interface (toilets)
- Collection and Storage (on-site)
- Conveyance
- Treatment (off-site)[8]
- Use and/or Disposal

[7] The data for the 5 study countries suggest that this is not an issue in these specific countries because a limited percentage of grey water ends up in septic tanks and other tanks.

[8] The column for off-site treatment has been left empty as there are many options, but this does not affect the classification for the HH survey.

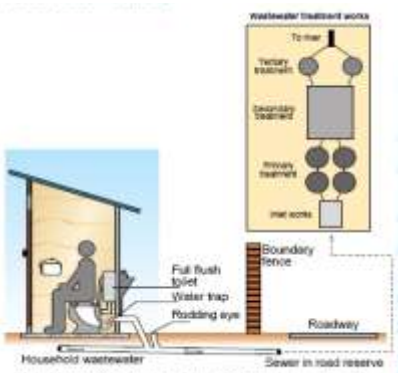
Therefore, allowing for the various combinations of functional options different sanitation systems can be developed (Table 6) and Section 2.3.3.1 provides visualizations of them[9]. These categories of sanitation technologies (Type 1 to 13) are referred to hereafter.

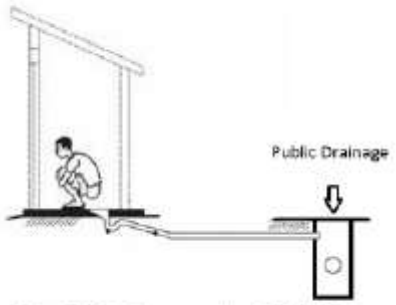
[9] The Sanitation Technology Options Handbook of South Africa, the GRET Cambodia report and WEDC sources have been used. This is not an attempt to provide technical guidance, but for use as a reference to ensure common understanding..

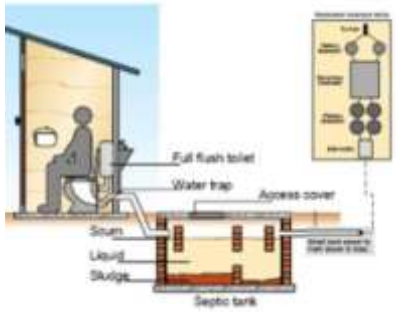
Table 6: Classification of sanitation technologies - user interface, storage, conveyance and treatment

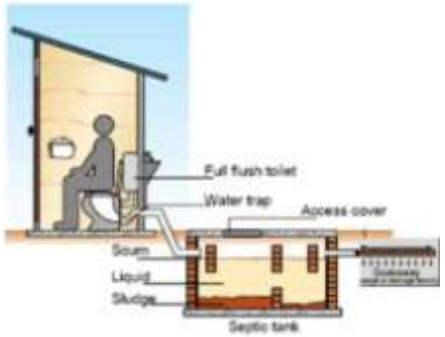
Type	User interface toilets)	Collection, storage and treatment (on-site)	Conveyance	Treatment (off-site)	Use and/or disposal	Description
1	Pour-flush or Cistern-flush	none	sewer			Direct connection to sewerage
2	Pour-flush or Cistern-flush	none	drains			Direct connection to drainage
3	Pour-flush or Cistern-flush	tank	small bore sewer/ drains FS E&T services			Individual septic tank to small bore sewerage or drainage
4	Pour-flush or Cistern-flush	tank	FS E&T services		(soak pit)	Individual septic tank with/without soak pit
5	Pour-flush or Cistern-flush	tank/ aquaprivy	small bore sewer/ drains FS E&T services		(soak pit)	Single chamber tank to small bore or drains (aquaprivy)
6	Pour-flush or Cistern-flush	tank/ aquaprivy	FS E&T services		(soak pit)	Single chamber tank with/without soak pit
7	Pour-flush	tank	FS E&T services			Holding tank (cesspit)
8	Pour-flush	single or double off-set pit	FS E&T services		(soak pit)	Single or double off-set pit
9	Pour-flush	single off-set pit	small bore sewer/ drains FS E&T services			Single off-set pit to small bore or drains
10	Pour-flush	sequential double pit	small bore sewer/ drains FS E&T services			Sequential double off-set pit to small bore or drains
11	Pour-flush	sequential double pit	FS E&T services		(soak pit)	Sequential double off-set pit with/without soak pit
12	Pour-flush	VIP or simple direct pit	FS E&T services			VIP or simple direct pit latrine
13	Hanging latrine	none	none			Hanging latrine or no latrine

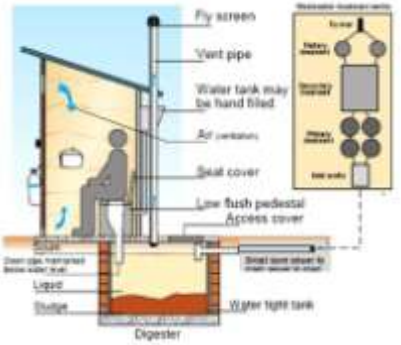
Figure 3 Schematic overview of sanitation systems encountered in the study cities

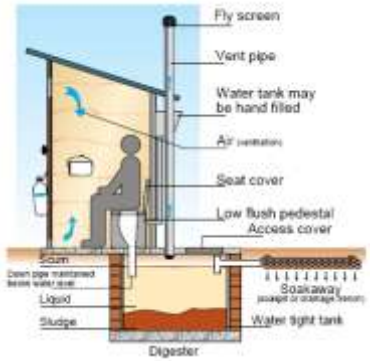
<table>
<tr>
<td>Type 1: direct connection to sewerage.
 

A cistern flush or pour-flush toilet connected to a sewer (pipe) network which drains to a treatment facility</td>
<td>Type 2: direct connection to drainage.
 

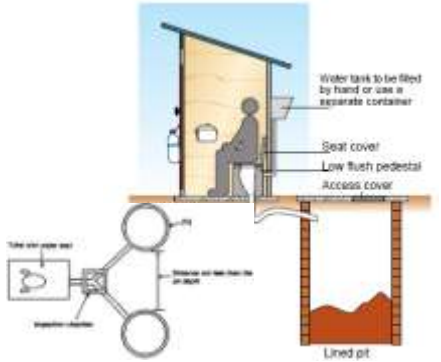
A cistern flush or pour-flush toilet connected to a drainage network</td>
<td>Type 3: individual septic tank to small bore sewerage or drainage.
 

A cistern flush or pour-flush toilet connected to a (double chamber) septic tank connected to a small bore or drainage network</td>
<td>Type 4: individual septic tank with/without soak pit
 

A cistern flush or pour-flush toilet connected to a (double chamber) septic tank connected to soak pit. Without a soak pit this is not considered safe.</td>
</tr>
<tr>
<td>Type 5: single chamber tank drain to small bore sewerage
 

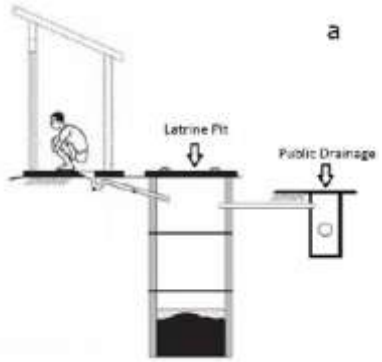
A cistern flush or pour-flush toilet connected to a single chamber water tight tank connected to small bore sewer. This is also called an aquaprivy, because the entry pipe is maintained below the water level in the tank.</td>
<td>Type 6: single chamber tank with/without soak pit
 

A cistern flush or pour-flush toilet connected to a single chamber water tight tank connected to soak pit. Without a soak pit this is not considered safe. This tank is also called an aquaprivy, because the entry pipe is maintained below the water level in the tank.</td>
<td>Type 7: holding tank
 

A pour-flush toilet connected to a water tight tank. The difference with a VIP pit is that the bottom of the pit is sealed. This tank is also called a cesspit.</td>
<td>Type 8: single or double off-set pit
 

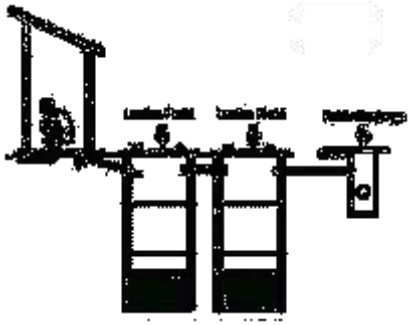
A pour flush toilet connected to a pit which is not directly below the toilet, making emptying easier. Variations: single pit (a) and double pit (b). Double off-set pits are used alternately for 6-8 months, after which nearly all of the pathogens will have died.</td>
</tr>
</table>

Type 9: Single off-set pit to small bore or drains



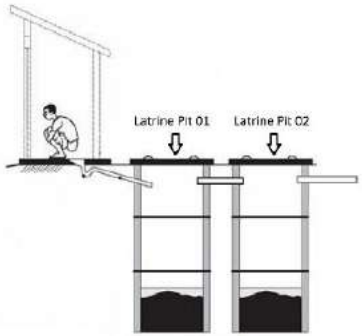
A pour-flush toilet connected to an off-set pit that is connected to a small bore or drainage network.

Type 10: sequential double off-set pits to drains



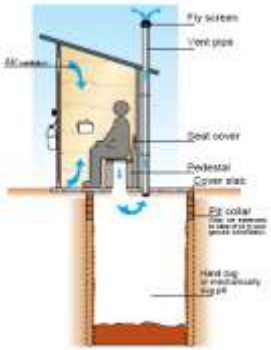
A pour-flush toilet connected to an off-set pit that is connected to a second pit which is connected to a small bore or drainage network.

Type 11: sequential double off-set pits to soak pit



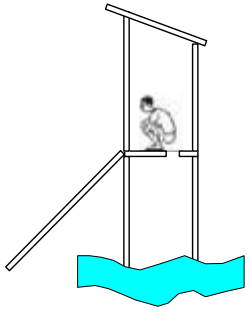
A pour-flush toilet connected to an off-set pit that is connected to a second pit which is connected to soak pit. Without a soak pit this is not considered safe.

Type 12: VIP or direct pit latrine



This is a dry or pour-flush toilet directly over a pit. The pit may be lined or not (depending on soil conditions). VIP latrines have a vent pipe to trap flies

Type 13: Hanging latrine or no latrine (other)



A hanging latrine is a raised platform without any storage, from which excreta falls directly into the sea, river or other body of water. In slums it often just falls on the ground. The only benefit of a hanging latrine is (some) privacy for the user. This should not be classified as sanitation (not even "unimproved" sanitation).

2.3.4 Income and payment for services

Income figures and payment for other services can provide insight into the affordability of fecal sludge emptying and transport services for households. Within the thinking around the Human Right to Sanitation, affordability is defined as not exceeding 5% of income.

Though emptying of tanks or pits is usually not a recurring monthly or even annual expense, the common one-time payment modality requires that households pay the emptying service from their monthly salary and households will judge affordability in relation to their monthly budget. Annualized figures for the cost of emptying will further help to assess whether costs are affordable. Following this logic, household perceptions of alternative payment methods, such as payment in installments, were also investigated in some countries.

Data on income and payment for services has been collected by all countries in the household surveys. Reliability of income data is always a concern, but the findings are consistent with official average income figures for the countries so they seem to be fairly representative.

For comparison with fees for other services, both the value as well as the payment modality have to be considered, in particular when fees are combined. For example the high fee collection rate of solid waste in Cambodia may relate more to the fact that it is included in the water bills, than to the service quality or affordability.

Considering rising inequality in the Asian countries it is recommended that for future studies median values of income and service payment are considered rather than average values.

2.3.5 Willingness to pay (WTP)

Willingness to pay can only be assessed for very specific service offerings (scenarios) and with replicable methodology. Crucial to enable comparison is:

- WTP for what? (Was the service scenario sufficiently clear to the respondent?)
- How did we measure it?

The willingness-to-pay question in the household survey asked “How much are you willing to pay for emptying service to improve the situation?”

While the situation has been qualified in earlier questions, this is different for each respondent, in each city, in each country and the question itself does not qualify the specific improvements. Therefore we do not actually know what new service scenario the respondent has assumed. Therefore the WTP data collected should be treated more as an indication of a household’s awareness of the problems relating to fecal sludge management and should not be considered as a true assessment of WTP.

2.3.6 Calculation of Fecal sludge production (theoretical and actual market size)

In theory, the size of the market for fecal sludge emptying and transport businesses should equal the amount of sludge produced. Fecal sludge production therefore depends on the size of the population using on-site sanitation facilities (either as standalone solutions or in combination with sewerage or drainage connections). The accumulation rate of fecal sludge in on-site collection and storage facilities further depends on factors including but not limited to climate, anal cleansing materials, the type of technology and frequency of emptying.

In practice, the market for fecal sludge emptying and transport businesses depends on the number of people that actually empty their pits or tanks and how often they do so. While the liquid fraction of septic tanks should be at least 2/3 of the tank volume to provide effective primary treatment, it seems that in practice most tanks are only emptied when raw sewerage starts to flow out (i.e. when they start to stink).

Since neither households nor businesses seem to have a very accurate recollection of emptying frequencies and volumes it is difficult to assess levels of FS production or accumulation. Therefore all market calculations are approximations.

In this study three methods of market size estimation were used (all these values are expressed in m^3 of fecal sludge per year):

- **P2** The theoretical market size calculated from the population using on-site facilities and an estimated sludge accumulation rate (P2). Two scenarios were considered: timely emptying considering design criteria (P2a) and emergency emptying when tanks overflow (P2b)
- **P1** The actual market size, calculated from the household survey data responses on emptying frequency, tank size and technology type (P1)
- **C** The current FS collected (C), based on the data from fecal sludge emptying and transport businesses on the number and type of tanks they empty annually

The difference between the theoretical market size (P2) and the actual market size (P1) could be considered to be the amount of fecal sludge disposed off directly by households, while the difference between the actual market size (P1) and the FS collected (C) could be interpreted as the fraction emptied by households themselves.

2.3.6.1 THEORETICAL MARKET SIZE (P2)

The calculation of the theoretical market size is a function of 2 values:

1. The population that theoretically needs services
2. The fecal sludge production per capita per year

Ad 1. The population that theoretically needs services

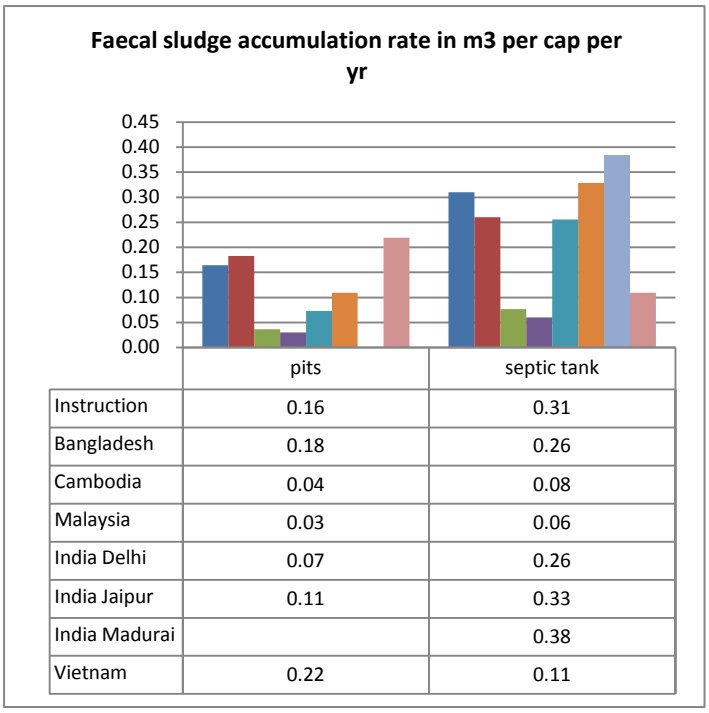
Most country teams based their calculations of the population requiring services on the household survey data. For those whose survey and samples only represent selected areas of their cities, the calculation is restricted to those areas. In principle all households with sanitation facilities of Type 3- Type 11 would require FSM services at some point in time. Given that most pits/tanks serve one household, the average number of users per pit/tank is equal to the average household size. Exceptions include Bangladesh, where corrections were made to accommodate for shared and communal toilets, and Malaysia where the report states that it is common for plots to have two toilets.

Commercial premises and institutions have generally not been included in the calculation of P2, which makes the comparison with C (current FS collected) problematic for those countries where this represents a significant segment of the market. In addition one could argue that those households that are currently connected directly to drains or use hanging toilets (Type 2 or Type 13 facilities) could be compelled to provide pre-treatment and therefore are potential future FSM customers. Conversely, many city authorities aspire to full sewerage coverage in the future which would reduce the FSM demand, but none of these scenarios can be reliably quantitatively assessed at the present time.

Ad 2.The fecal sludge production per capita per year

Except for Malaysia and Cambodia, the value of the fecal sludge production per capita per year is an assumed value determined by the country team. As can be seen in Figure 3 there is significant variation between the rates assumed by the different countries and there is often little research available. When defining the accumulation rate it is important to bear in mind that the majority of pits and tanks found in the Asia study countries drain effluent, either via effluent pipes and/or because the bottom of the pits are not sealed. No water tight holding tanks (cesspits) were found.

Figure 4: Assumed FS Accumulation Rates used in FS calculations, by Survey Location (m^3/ cap/ year)



	pits	septic tank
Instruction	0.16	0.31
Bangladesh	0.18	0.26
Cambodia	0.04	0.08
Malaysia	0.03	0.06
India Delhi	0.07	0.26
India Jaipur	0.11	0.33
India Madurai		0.38
Vietnam	0.22	0.11

The contents of pits and septic tanks consist of 2 fractions:

- a semi-solid fraction
- a liquid fraction

As the liquid fraction flows out of the septic tank, the tank slowly fills up with a semi-solid sludge fraction, while the remaining tank volume is taken up by the liquid fraction. The volume to be emptied is equal to the effective storage volume of the tank at any given time, and what changes is the portion of sludge in relation to the liquid fraction. The need for emptying the tank is determined by the portion of the tank taken up by sludge, as a minimum volume for the liquid fraction is required to ensure proper anaerobic decomposition and sufficient retention time to ensure that the effluent flowing out is not harmful (ideally a retention time of at least 2 days is required).

Under a scenario of timely emptying (P2a), the maximum sludge level is generally determined by the requirement that two-thirds of the tank should be filled with liquid to ensure proper anaerobic decomposition. This means that the sludge volume may not exceed one-third of the effective storage volume of the tank. However, unless scheduled emptying is practiced, it is difficult to ensure timely emptying.

Under a scenario of emergency emptying (P2b), however, the tank is only emptied once raw sewage flows out and the tank starts to stink. This basically happens when the retention time of the liquid fraction of the tank is less than 2 days, i.e. when the volume entering the tank in a 2-day period exceeds the volume available to the liquid fraction. Under this scenario the sludge takes up a much higher percentage of the total effective storage volume of the tank, although this depends greatly on the size of the tank and the average daily volume entering the tank. The use of full flush or pour flush technologies affects the volume of water entering the tank[10], and similarly the entry of grey water into the tank will greatly increase the minimum volume required for the liquid fraction. The resulting emptying frequency under this scenario (and thus the average annual volume to be emptied) is much lower than under the scenario of timely emptying.

Although the upper limit for the sludge volume are different under the two scenarios, in both cases the emptying frequency, (and with that the annual volume to be emptied) will depend on the sludge accumulation rate. The accumulation rate of the semi-solid fraction is much lower than the feces produced per person per year due to decomposition and compression processes in the tank/pit. These processes are a function of time,

[10] A 5 person household using a cistern flush toilet produces about 0.51m^3, assuming 2 days retention time. A 5 person household using a pour flush toilet requires 0.16m^3 assuming 2 days retention time. Thus in a household with a septic tank of 2m^3, the solid fraction can reach a maximum volume of 1.5m^3 (in case of cistern flush) or 1.8 m^3 (in case of pour flush) before insufficiently treated effluent starts flowing out of the tank.

and as a result the accumulation rates reduce significantly if tanks are emptied less frequently (>1 year)[11]. International literature suggests sludge accumulation rates between 0.025-0.09 m3/cap/year, where the accumulation rate depends on the type of facility being used, the type of cleaning materials used and whether or not grey water flows into the tank[12]. It may be clear that the main determinant of the sludge accumulation rate of any given tank will be the number of persons making use of that tank.

As a result of the above, under a scenario of timely emptying (P2a), the next emptying can be determined by dividing the effective storage capacity of the tank by three[13], and subsequently dividing the result by the sludge accumulation rate. In the case of emergency emptying (P2b), the next emptying can be estimated by subtracting the average volume entering the tank in a two-day period from the effective storage capacity of the tank, and dividing the result by the sludge accumulation rate. Larger pits obviously allow longer intervals between emptying under both scenarios.

Malaysia based the estimation of the sludge accumulation rate for septic tanks on the findings by IWK that a 3 yearly desludging frequency could still ensure the minimum free liquid volume of 1.13m^3 required to maintain the anaerobic effectiveness, as determined by measuring the effluent quality. Given the standard tank size of 2m^3 and a typical HH of 5, this results in an average sludge accumulation rate of 0.06 m^3 per person per year.

Cambodia estimated the emptying volume based on the household survey data collected for different tank sizes. Based on the volumes of each emptied facility (per capita) they calculated an average of 0.06m^3 per capita per year and individual values of: single pit facility=, 0.04m^3/cap/yr; double pit facility = 0.13m^3/cap/ year; septic tanks =0.08m^3/cap/year.

Bangladesh and **India** state that they considered the pit volumes when estimating the sludge accumulation rates, but do not explain how they arrive at their assumed FS production rates.

Since assumptions about fecal sludge accumulation have a significant impact on the outcome of the sludge production calculations, and considering the variations in data and assumptions between the countries, this study will also express the market size in households per year and percentage of the total households requiring FS emptying services in a given year. The latter is called “acceptance rate[14]” in the Malaysian study.

2.3.6.2 ACTUAL MARKET SIZE (P1)

For the calculation of the actual market size using data from the household surveys, detailed instructions were provided by the Gates Foundation. (see annex 1). The basic premise is to use the percentage of pits emptied for each frequency class to develop an annualized figure, i.e. the number of pits to be emptied in any given

[11] In a publication by Gray on septic tanks in the US, it was shown how the sludge accumulation rate reduces significantly after 1 year. The Influence of Sludge Accumulation Rate on Septic Tank Design, N. F. Gray, pages 795-800, Environmental Technology, Volume 16, Issue 8, 1995.

[12] WHO (Franceys et al. 1992) suggest the following as maximum rates:

- 40 litres per capita per year for excreta retained in water where degradable anal cleaning materials are used
- 60 litres per capita per year for excreta retained in water where non-degradable anal cleaning materials are used
- 60 litres per capita per year for excreta retained in dry conditions where degradable anal cleaning materials are used

WEDC in its low cost sanitation learning materials on septic tanks and aqua privies suggests:

- 25 litres per capita per year for black water only
- 40 litres per capita per year for black water+ grey water

Gray (1995) found an average accumulation rate, irrespective of sludge age, of 0.234 litres/cap/day (0.085m3/ cap/year).

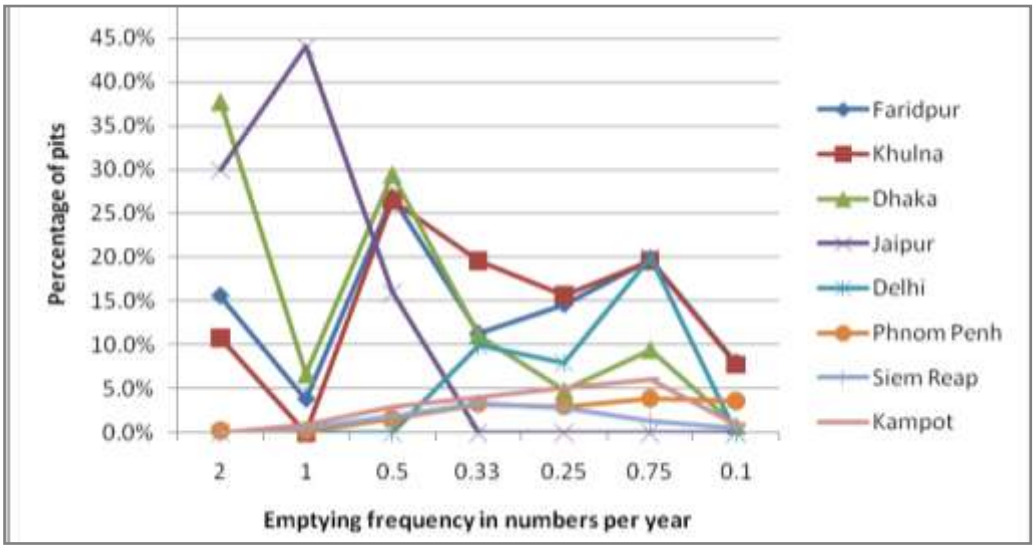
[13] Strictly speaking, this does not apply for dry pits, which have a higher sludge accumulation rate, but do not have the liquid volume.

[14] Acceptance rate: percentage of the population of the city that will use fecal sludge emptying services in any given year.

year. This is then multiplied by the average pit volume for all pits. Similar calculations are done for septic tanks and holding tanks.

The calculation philosophy is essentially sound except that when trying to express the market size in m3 of fecal sludge it is not recommended to use the average tank volume for all pits since smaller pits require more frequent emptying than larger pits. Assuming that the average tank volume is similar for all frequency classes significantly distorts the outcome of the calculation, resulting in an overestimation of the total volume of FS to be emptied[15]. The distortion has less impact in cities like Jaipur where the emptying frequencies are very close together, but in Khulna the distortion could result in a significant overestimation of the market size. (see Figure 4)

Figure 5: Pit Emptying Frequencies by Survey City



2.3.6.3 THE CURRENT FS COLLECTED (C)

The calculation of the volume of fecal sludge collected by mechanical and manual emptiers applies the following equation:

(Number of trucks x m3 capacity of trucks x number of trips per year) + (number of pits emptied manually per year x PV) + (number of septic tanks emptied manually per year SV)

The equation is valid although where the percentage of manual emptying is high, the calculation will be the same as the one for actual market size (P1). For example for Khulna and Faridpur with 96% and 86% of the households using manual emptying respectively, there is no added value in undertaking this calculation.

[15] This is because the calculation of the average tank size only takes account of the number of tanks and their different sizes. Once we annualize the volume being emptied by multiplying the tank volume by the emptying frequency (times per year), we are in fact putting weights on the different tanks sizes with larger weight being given to smaller tanks with higher emptying frequencies. The greater the difference emptying frequencies, the greater the calculation error will be if the total average tank size is used (the overestimation will be in the order of less than 25% if emptying frequencies are very similar, but can grow to as much as 300% if emptying frequencies vary greatly). Instead, it is necessary to use the average tank size for each frequency class.

2.3.7 Analysis of disposal practices and incentives for safe disposal

Safe disposal of fecal sludge can be done at suitably-designed landfills, at fecal sludge treatment plants, biogas plants etc. The capacity of the facility should be sufficient to accommodate the emptied volume (see above). Except for the Malaysia and Vietnam report, there is little information provided on the type of treatment plants available, and less on operational and financial aspects.

Notwithstanding the existence of appropriately designed and operated disposal sites, safe disposal is also dependant on the disposal practices of FS emptying and transfer businesses. The following aspects are considered:

a. Cost of transport to disposal sites, taking into account distance and fuel costs
b. Whether payment is required or cost incurred by the FS emptying/ transfer business for disposing the sludge or payment is made to the business by the receiving plant
c. Fines and enforcement of regulations regarding disposal by FS emptying/ transfer business
d. Other influencing factors that might be country specific

Figure 6: Impact of FS Transfer Distance on Costs

The Cambodia team used an interesting tool to analyze the first point, i.e. transport costs to disposal sites with the aid of a map. They estimated transport costs in relation to the distance from disposal sites. (see figure 5). The method is valid for Cambodia, because potential customers are spread throughout the whole city rather than confined to specific locations.

2.3.8 Analysis of the institutional and legal framework

It is not clear whether the analysis of the institutional and legal framework for fecal sludge management was considered an integral part of the study by all country teams. Some country reports provided greater detail than others. However, what clearly emerges from the documents is that enforcement and regulation is an essential part of effective FS management.

The minimal information that needs to be considered for the analysis of the institutional and legal framework is:

- Overall roles and responsibilities
- Regulation of customer behavior
- Regulation of customer emptying practices
- Regulation of the collection, transfer, treatment, re-use and disposal practices
- Financial flows

2.3.9 FINANCIAL AND BUSINESS MODEL ANALYSIS

A model income statement format with the key parameters for calculation of income and expenditure of the business was developed by the Gates Foundation to guide the country teams in the collection of required financial information. A checklist of key guiding questions was developed to collect the information required for subsequent financial calculations and analysis. Each country team interviewed a selected number of collectors to obtain their current financial situation.

Mechanical FS extraction businesses were selected for the preparation of model financial plans in all countries. For India, Bangladesh and Vietnam small sized companies with one or two trucks, each having a capacity of one to three cubic metres, were selected. In Cambodia and Malaysia medium sized operators with an average of three trucks, each a having capacity of five to eight cubic metres were considered for the business modeling.

A standard format was provided by the Gates foundation to calculate additional financial results such as income statement, balance sheet and various financial ratios to assess the viability of the various business models. Three countries i.e. India, Bangladesh and Vietnam applied the agreed financial plan format to produce business models for their respective countries whilst Cambodia and Vietnam used their own format for financial modeling. Nevertheless, Malaysia and Cambodia results could be easily compared to the results from India, Bangladesh and Vietnam since the methodologies used were quite similar.

2.3.10 BUSINESS CASE ASSESSMENT

The business case assessment aims to identify the potential drivers for initiating improvements in the fecal sludge extraction and transport markets. It includes both financial and non-financial aspects and ultimately justifies how the proposed activities will make fecal sludge extraction and transport in the respective cities more financially, socially and environmental sustainable. It should also present the positive and negative externalities.

Only three cases have been put forward by the countries. The cases have been analyzed for key financial indicators as well as their wider benefits. The latter has been done qualitatively only, no quantitative data or indicators were used for this.

3 RESULTS AND ANALYSIS

3.1 BACKGROUND ON THE COUNTRIES OF THE STUDY

The study involved 15 cities in five countries of South and Southeast Asia. These countries have urban populations ranging between 22%-30%, except Malaysia which is near to 70%. All countries have fairly high urban access to improved water supply and are making rapid progress in urban sanitation (see JMP figures in Table 7).

Table 7: JMP data by survey Country

Country	Population	urban population %	urban population (millions of people)	urban water improved	urban san improved	urban san shared	urban san unimproved	urban san OD	urban san improved (millions of people)	urban san shared (millions of people)	urban san unimproved (millions of people)	urban san OD (millions of people)
India	1,181,412,000	29%	342.6	96%	54%	21%	7%	18%	185.01	71.95	23.98	61.67
Bangladesh	160,000,000	27%	43.2	85%	56%	26%	15%	3%	24.19	11.23	6.48	1.30
Cambodia	14,562,000	22%	3.2	81%	67%	9%	2%	22%	2.15	0.29	0.06	0.70
Vietnam	87,096,000	28%	24.4	99%	94%	5%	1%	0%	22.92	1.22	0.24	-
Malaysia	27,014,000	70%	18.9	100%	96%	4%	0%	0%	18.15	0.76	-	-

There are no exact figures as to what proportion of urban households require fecal sludge emptying services in these different countries. For in India EAWAG (2010) estimates that 46% of the urban population use on-site facilities. However sewerage coverage is advancing very fast in India, with the commitment to 100% safe sanitation in the 11th Five Year Plan. The 2008 National Urban Sanitation Policy (NUSP) obliges states and cities to make formal sanitation plans, and involves an annual ranking of cities against sanitation related performance criteria. In recent years India has also taken a stronger stance against traditional manual scavenging, though in theory the practice has been banned since 1993. The data from the three surveyed Indian cities found that most emptying is being done mechanically.

In Bangladesh conventional sewerage is only found in Dhaka covering about 20-25% of the urban population. However, both in India and in Bangladesh, the practice of direct connection of toilets to storm water drains is prevalent, and these are often mis-reported as sewer connections. In Bangladesh in particular the study found that on-site sanitation facilities are only constructed when households have no possibility of connecting their toilets directly to drains. Awareness and campaigns against manual emptying in Bangladesh have not been as prominent as in India and the majority of tank and pit emptying continues to be done manually.

Furthermore, in both India and Bangladesh, sanitation for the urban poor remains an enormous challenge. Populations of unrecognized, unauthorized slums are often not included in sanitation coverage figures, so it may well be that figures are less promising than they look.

In Cambodia and Vietnam pre-treatment at household level is common before discharge to sewers or drains. In Vietnam pre-treatment at household level is mandatory as centralized treatment capacity is very limited. In Cambodia practically all sewerage networks are solids-free sewers and drains. In theory this means that practically all urban households in Vietnam and Cambodia need emptying services.

It is noteworthy that connection to storm water drains is wide spread in four of the study countries and clear distinction is not always made between sewers, small bore sewers and surface or storm drains. The country

reports also made no distinction between connections to closed or open drains, but anecdotal evidence suggests that some households are connected directly to open drains and that ponding or running effluent in open drains or streets is common.

Malaysia is the exceptional case in this study because it has very high sewerage coverage, an evolved fecal sludge management system and reliable data regarding on-site facilities. Traditionally sanitation was the responsibility of the local authorities but due to lack of capacity in the smaller local authorities this responsibility was taken over by the Federal Government in 1993. From 1994-2008 Idah Water Konsortium (IWK), a wholly-owned government company, performed scheduled desludging of household sanitation facilities every 2 years. In 2008, under new legal provisions which provided more options for customers and intended to increase market capacity, desludging services became demand-based instead of scheduled and open to competition. Licensed private contractors are also allowed to provide emptying services in direct competition with IWK which still manages the fecal sludge treatment facilities.

Treatment capacity is insufficient in all countries except Malaysia. In Bangladesh the only functional treatment plan is in Dhaka, while in Cambodia sewers drain to natural wetlands and rivers that ring the city. Treatment capacity in Vietnam is insufficient as well but there are ongoing initiatives for re-use and composting.

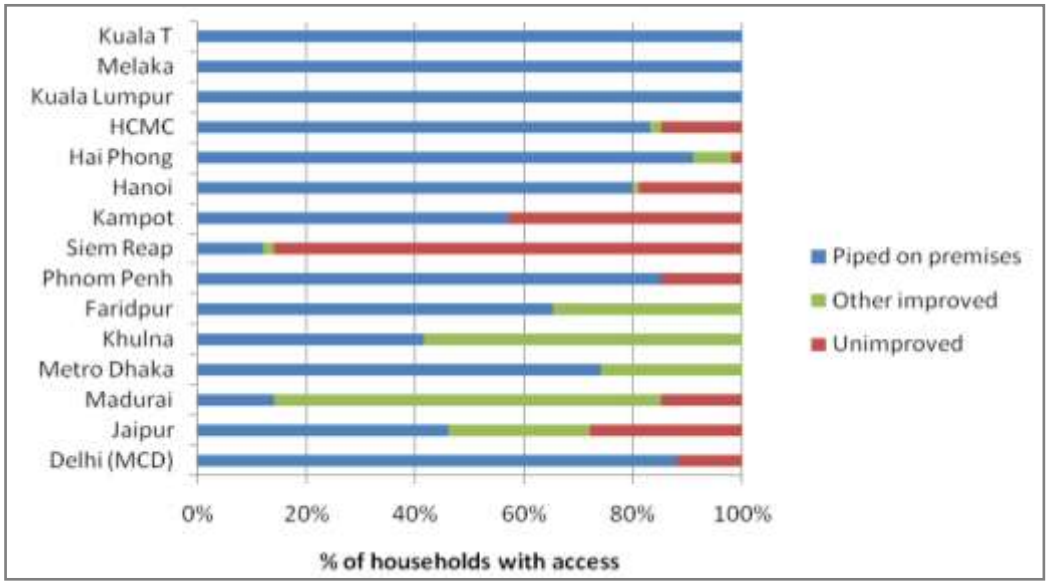
3.2 Situational analysis of extraction/transportation

3.2.1 Demographic and water supply and sanitation situation of the cities studied

As noted in Section 1.4, of the fifteen cities in this study there are 3 very large cities each with populations over 6 million (Delhi, Dhaka and HCMC), 6 relatively large cities with populations between 900,000 and 6 million people (Hanoi, Hai Phong, Kuala Lumpur, Phnom Penh, Khulna, Jaipur and Madurai) and 5 smaller cities with populations of less than 500,000 people (Melaka, Kuala Teranga, Siem Reap, Faridpur and Kampot). The number of people per household in these cities ranges from 3.5 in Vietnam to 7 in India. As was seen in Table 1 the very large and relatively large cities are also the ones that are growing fastest, not only in population, but especially in numbers of households, reflecting the emerging trend towards smaller nuclear households and possibly urban migration where only part of the household migrates.

Data on water supply and sanitation coverage comes from different sources and different years for each country and therefore cannot be compared. However the coverage graph below gives an indication of the situation (Fig 6.).

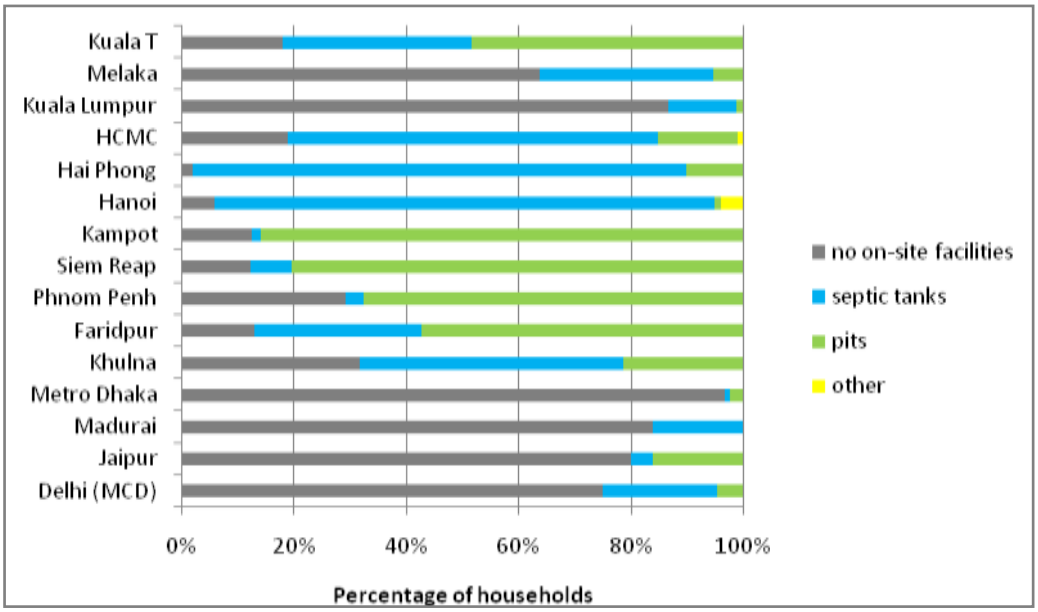
Figure 7: Access to Water Supply by JMP classification by Survey City, sorted by Country



Unfortunately the country reports do not consistently provide sanitation coverage data following the JMP classifications. Interpreting the data improved sanitation coverage seems to range from 40% in Khulna to 100% in Malaysia. Shared toilets constitute a significant portion of unimproved coverage in both India and Bangladesh (24%-38%) and a considerable percentage in Vietnam and Cambodia (6%-16%). The reports do provide an estimate of the population with on-site sanitation facilities, that is: pits, septic tanks or other types.

This gives an idea to what extent these are on-site sanitation cities. In Figure 7 it can be seen that all cities in Vietnam and Cambodia, as well as the minor cities in Malaysia and Bangladesh can be considered on-site sanitation cities, while in India and the medium cities in Bangladesh and Malaysia off-site sanitation dominates. The group "no-site facilities" refers to all households having either sewerage, direct connection to drains or practicing open defecation. There's nothing to be emptied.

Figure 8: Percentage HHs in Survey Cities with On-Site Sanitation (connected/ not connected to drains/ sewers) [16]



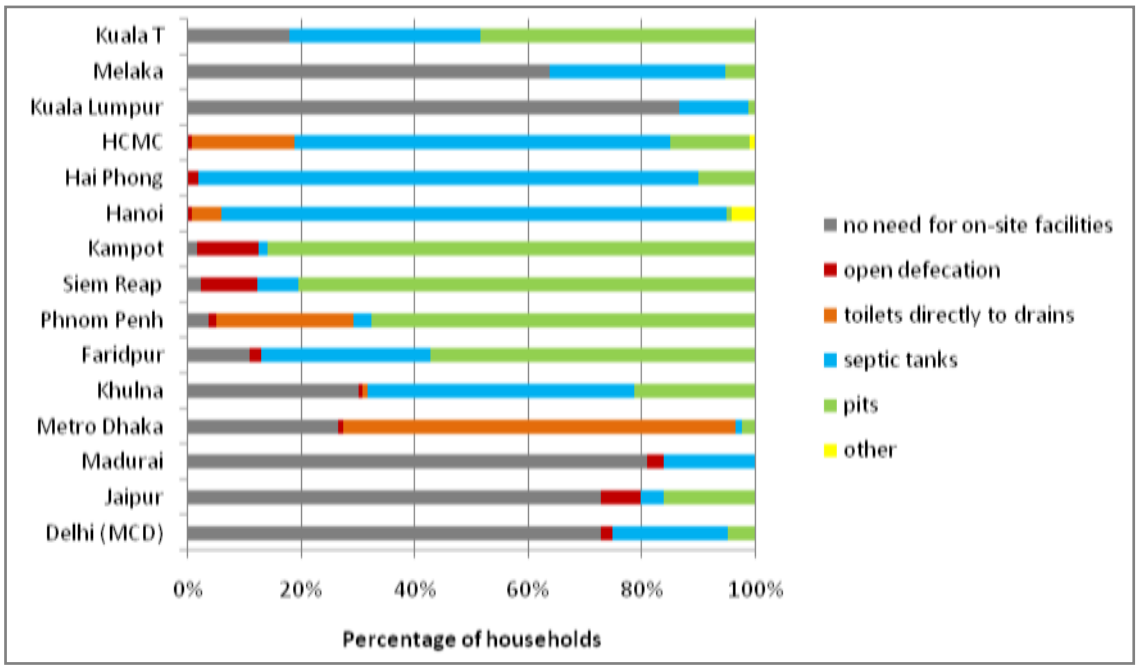
However these figures only give a static picture of the potential market for fecal sludge emptying. It is important to also take into account the potential increase in centralized sewerage as well as population growth, natural and migrant. There are no data to assess the increased coverage of sewerage versus population growth. For India it is known that the relatively low percentages of households with on-site facilities in these cities can be explained by the rapid expansion of sewer networks in those cities[17]. This is pushing fecal sludge businesses to the periphery of the city. In Madurai this effect is being felt strongly by the sector but less so in Delhi where the population is currently increasing at a faster rate than the connection to sewerage.

[16] It is worthwhile noting that pits in Cambodian cities are typically of two types, i.e. single and sequential double pits (see 2.3.3 on sanitation technology types). Of particular concern is the India report finding that facilities classified as 'septic tanks' in Delhi and Jaipur do not actually treat the sewage. In Vietnam the 'other' category typically refers to holding tanks (not water tight) and double vault latrines. None of these are emptied by paid emptiers.

[17] As mentioned in footnote 5, Section 2.2.1, it is questionable whether these cities are representative of cities in India, considering that figures from 2010 show that only 4.5% of the total number of towns in India have underground sewerage (NIUA 2010).

In Dhaka the low demand for FSM services reflects lack of enforcement of the building codes rather than high sewerage coverage, since 69.9% of the sampled HHs connect their toilets directly to city storm water drains. This phenomenon is also found in other cities, but to a lesser extent. Under a scenario of stronger enforcement the graph might look like Figure 9. All the households practicing open defecation or having their toilet connected directly to drains (red and orange) would be required to construct some form of on-site facilities if enforcement of building and environmental codes was stricter. In Vietnam, due to the lack of sewerage treatment capacity, a high number of households connected to sewers and drains, are obliged to construct septic tanks or pits as well.

Figure 9: HHs that would require on-site sanitation under a scenario of enforcement



From the above it can be seen that fecal sludge management in general and emptying services in particular, are a significant part of the solution towards safe urban sanitation in all five countries. It also indicates the urgency with which enforcement of building and environmental codes is required regarding sanitation and FSM.

3.2.2 Institutional and legal framework of sanitation and FSM by country

In the following section an overview is given of the legal and institutional information provided in the country reports. For several countries this information is insufficient to draw any conclusions on the legal framework or roles and responsibilities in the sector[18], in particular related to the regulation of household behavior and the regulation of FS emptying and transport businesses, although all the country reports refer to the importance of enforcement and legislation in their conclusions and recommendations.

[18] SNV is aware of some of the relevant secondary information that could be referred to but there has not been enough time to include this in the report. Only two small references for Cambodia have been added . For Malaysia and India, the interim reports were used as those give more detailed information on the legal framework

Table 8: Overview on main legal and institutional situation by country

Issue	India	Bangladesh	Cambodia	Vietnam	Malaysia
Main characteristics					
FSM under WSS or solid waste?	Seems to be under solid waste	WSS		WSS	WSS
Centralized or decentralized responsibility?	Decentralised responsibility	Decentralised responsibility	Decentralised responsibility?	Decentralised responsibility of PPC	Centralized responsibility of Federal government
Overarching framework					
Main legislation	Municipal Wastes (Handling and Management) Rules (2000) Many other acts and regulations are mentioned	Local Governance Act (2009)			Water Industry Services Act (2006) Environmental Quality Act (1974) Environmental Quality regulations (EIA-1987), Environmental Quality Sewage and Industrial Effluents Regulations (2009)
Main responsible ministry	Ministry of Urban development (MoUD)		Ministry of Public Works and Transport (MPWT)	Ministry of Construction (MoC), delegating to the Provincial People's Committees (PPCs)	Ministry of Energy, Green Technology and Water
Other involved ministries/ entities	State Pollution Board	Environment (through the District Departments of Environment)	Ministry of Environment (MoE), Ministry of Land Management and Urban Planning (MoLMUP), Ministry of Industry, Mines and Energy (MIME), Ministry of Water Resources and Meteorology (MoWRAM)	Ministry of Health (MoH) and Ministry of Planning and Investment (MPI) and Ministry of Finance (MoF)	Ministry of Natural Resources and Environment
Main regulator	Central Public Health and Environmental Engineering Organisation? (under MoUD)			Provincial department of Construction of PPC (Dept of Transportation and Public Works in HCMC)	National Water Services Commission (SPAN)
Main responsibility for implementation	Urban local bodies (state governments provide technical and policy support)	Water and Sewerage Authorities (DWASA, KWASA), others: under the WSS section of the City corporations (larger cities) and Municipality (smaller cities- Faridpur)		Hanoi Sewerage and Drainage Company (HNSADCO) in Hanoi, SADCO of the local authorities in the other cities.	National Water Services Commission (SPAN)
Involved utility	Delhi Jal Board (DJB), Water Supply and Sewerage Boards			Urban Environment Companies (URENCO)	Indah Water Konsortium (IWK)
Policy development	National Urban Sanitation Policy, Draft Policy Paper on Septage management in India		MPWT		National Water Services Commission (SPAN)
Plans for improvement	City Development Plans				National Water Services Commission (SPAN)
Local regulation	Delhi Cleanliness and Sanitation by-law (mostly solid waste) Delhi Jal Board Act (1998)		Provinces and Municipalities		

Issue	India	Bangladesh	Cambodia	Vietnam	Malaysia
Local responsible agencies	State Urban Development Departments, Public Health Engineering Departments, Urban Local Bodies				none?
Regulation at household level					
Building codes and designs of on-site facilities	1983 National Building Code of India - Part IX Plumbing Services, Drainage and Sanitation. 1985 Code of practice for the design of septic tanks	Bangladesh National Building Code 1993?, Dhaka Metropolitan Building Construction Rules 2008 [added by SNV]	Anukret 86 ANK/BK/December 19, 1997 mentions obligations of households and specifies minimal design standards for septic tanks [added by SNV]	Guidelines for the development of toilets and septic tanks in rural areas by MoH, now being updated with MoC	Malaysian Standard Code of Practice for the Design and Installation of Sewerage Systems (1991), Guidelines for Developers on the Design and Installation of Septic Tanks (1995), Guidelines by the MoH for the construction of pour flush latrines.
Enforcement of building codes	unclear		Municipality [added by SNV]	Requirement to submit designs to the local authority for construction, but no adherence in practice.	?
Discharge by households	Draft guideline on septage generation, emptying and quality (developed by CSE for Ministry of Urban Development -May 2011)		Anukret on social order (1994): toilets that lacking good sanitation and leading to hygiene problems shall be warned, then fined 20,000 Riel (3 USD) [added by SNV]		Environmental Quality regulation prohibits the discharge of sludge into land or Malaysian waters.
Emptying frequencies					Regulated in the Water Industry Services Act
Enforcement of emptying frequencies	Delhi Pollution Control Committee (DPCC), State Control Boards in Jaipur and Madurai (not effective)				SPAN maintains a database of on-site facilities and sends out reminders to customers.
Regulation of emptying practice					
Who is allowed to operate?	Anybody		DPWT and others	URENCO and others	IWK and private permit holders
Permits and licences	No licence for desludging needed Vehicles licences not needed when using tractors		MoE permit for discharge or transportation of effluent> 10m3 per day, MPWT licence for vehicles and use of vehicle, MIME gives water licences in theory could give sanitation licence as well	Companies require a standard business licence to operate. In HCMC a registration at the District Office of Natural Resources and Environment is required.	Permit for desludging services by Water Services Commission (SPAN) Permit for operation of pressure vessel by Department of Occupational Safety and Health (DOSH) Road worthiness testing by Road Transport Department - PUSPACOM Registration of contractors by Construction Industry Development Board (CIDB)
Manual scavenging	Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act 1993				ND
Safe emptying practice	non-existent				ND

Issue	India	Bangladesh	Cambodia	Vietnam	Malaysia
Dumping and disposal	Mechanical emptiers mention harassment by police and the environmental departments for illegal dumping, in spite of the fact that there are no designated dumping places. In Madurai dumping by emptiers in manholes is silently accepted.		Fine for illegal dumping?	Government Decree 150/2005/NP-CP states a fine of an equivalent to 4.8- 14 USD for dropping sludge during transportation in the city or not maintaining hygienic conditions. (not enforced)	Environmental Quality regulation prohibits the discharge of sludge into land or Malaysian waters.
Enforcement dumping and disposal	non-existent				DOE?
Fair pricing/ tariff setting	none			MoF in cooperation with MoC, but in practice PPC limit price increases	SPAN
Investigate to public complaints					SPAN
Regulation of treatment and re-use practices					
Who is allowed to operate?				URENCO and private companies, but only one private company in HCMC	IWK manages all treatment
Regulation				MoH is currently drafting guidelines for rhte composting of human waste	IWK has the obligation to receive all sludge
Permits…					IWK has a concession contract
Discharge					DOE
Funding of treatment			Phnom Penh: 10% surcharge on the water bill for "sewerage charge"	Government Decrees 67 (2003) and 88 (2007) require cities to raise 10% surcharge on water bills for environmental protection.	

3.2.2.1 KEY STAKEHOLDERS ROLES AND RESPONSIBILITIES

In all countries, except Malaysia, urban sanitation and fecal sludge management is a decentralized responsibility, mostly with the urban local bodies or city corporations. Interestingly this was also the case in Malaysia prior to 1993, but in 1993 the responsibility was taken over by the Federal government due to a lack of capacity of the local authorities. The report mentions that there are still 3 states (and 1 municipality) where local authorities are directly responsible for FSM.

The national responsibility for fecal sludge management is either with the Ministry of Urban Development, Public Works or a water related ministry. Ministry of Environment and Ministry of Health are other involved ministries. Except for Vietnam and Malaysia, these national responsibilities are not clearly translated into local responsibilities and for none of the government stakeholders is fecal sludge management a priority.

Some of the country reports identify confusion over definitions which contributes to lack of clarity over roles and responsibilities in practice. While septic waste or fecal sludge is often not mentioned as part of the definition of domestic waste, it is also not included in the definitions of sanitation which tend to focus on sewerage. Without explicit legislation no agency takes responsibility. For example, in Bangladesh the DWASA (Dhaka Water and Sewerage Authority) is only concerned with households that connect to sewerage, while in India both the Delhi and Madurai officials see no role for the municipality in emptying of septic tanks or pits (only those of government institutions and schools). They perceive the problem mainly in terms of a lack of sewerage, treatment plants and a low willingness to connect on the part of the public. This one-dimensional approach fails to address areas where sewerage is neither technically or financially viable or those areas where land tenure prevents either customers or the authorities from providing sewerage. It is worth mentioning that the national government of India is making initiatives to push local authorities to give higher priority to urban sanitation.

Regulation of tariffs for fecal sludge emptying and transport services occurs in both Vietnam (by PPC) and Malaysia (by SPAN).

Box 2: Malaysia's FSM situation

Historically sanitation was the responsibility of local authorities but due to lack of capacity in the smaller local authorities, the responsibility was taken over by the Federal Government in 1993. The Federal Government gave an O&M concession to a private company, Indah Water Konsortium (IWK), to provide sewerage services within Peninsular Malaysia. In 2000 IWK became a wholly-owned government company with assets still owned by the local authorities. From 1994-2008 scheduled desludging of household sanitation facilities every 2 years was compulsory. Private service providers were sub-contracted by IWK to complement their operational capacity.

In 2008, the Water Services Industry Act (WSIA Act 2007) came into force giving a regulatory role to National Water Services Commission (SPAN). Desludging services became demand-based and competitive as private contractors holding SPAN permits are also allowed to provide emptying services in competition with IWK for private customers. IWK is still responsible for all public sector customers and continues to manage the fecal sludge treatment facilities. This continues to give them the largest market share though they still subcontract to private providers to increase their service capacity.

SPAN falls under the Ministry of Energy, Green Technology and Water, while the Department of Environment (DOE) under the Ministry of Natural Resources and Environment has an indirect role in ensuring that activities do not adversely impact the quality of the environment.

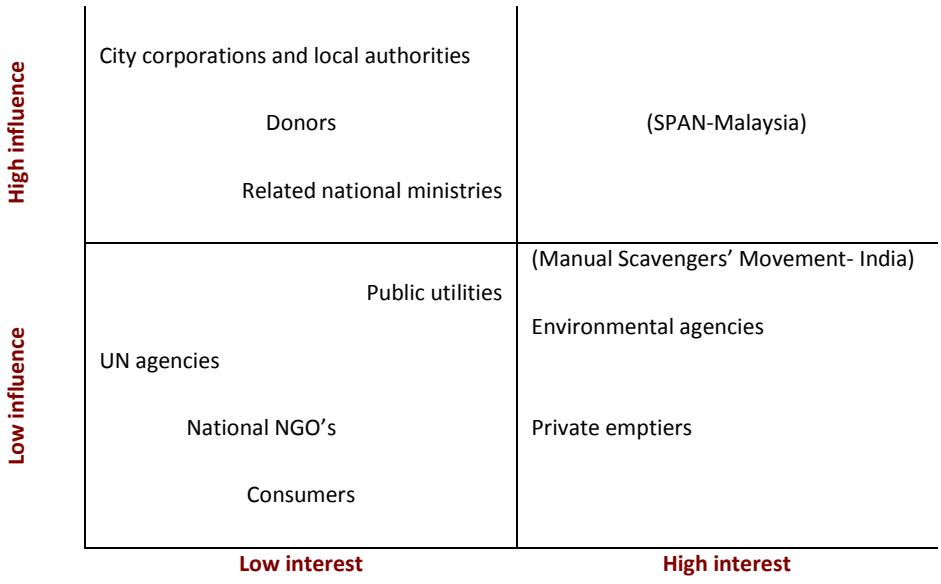
Although households and other customers, as well as the private sector are all key stakeholders, at the moment their influence over sector change is minimal due to a lack of organization and association. An exception is the organization against manual scavenging in India (Safai Karmachari Andolan[19]), which continues to lobby for the abolition of the practice. Private sector providers are not organized and often informal which reduces their influence even more. The private companies in Malaysia have actually reduced their engagement since on-demand desludging was introduced.

It is clear that the larger (public) companies such as the IWK in Malaysia and the public companies in Vietnam have significant potential to influence sector development but their interest in improving the situation is low because FSM is perceived as a "must do" activity. Government or PPC control or political pressure regarding tariff setting often results in services that have to be cross-subsidized by other sources of income, undermining interest in service quality or customer focus.

Treatment and re-use is either absent or managed by the public sector. Many Asian countries experience limitations on re-use due to either social unacceptability of the concept, or the limited capacity of the sectors of society for whom this activity is restricted, i.e. low caste with historically limited education or access to finance. The exception is one private composting company in HCMC. Interest in improvement of fecal sludge management is low.

The country documents do not consistently report on or provide sufficient detail of the influence of international donors and development banks such as JICA, ADB, World Bank or INGOs, despite the fact that these organisations have significant influence on technical decisions and investment streams in the sanitation sector. It is therefore not possible at this stage to identify key decision making themes or priorities for investment.

Figure 10: FSM Stakeholder Mapping



[19] Safai Karmachari Andolan (SKA) is a national movement committed to the total eradication of manual scavenging and the rehabilitation of all scavengers for dignified occupations.

Figure 10 is a tentative influence/interest matrix based on the data in the country reports. As mentioned, the information available is not sufficient to draw region-wide conclusions and such diagrams are more suitable for use at country level. However this diagram aims to illustrate the importance of stakeholder analysis for understanding the environment in which fecal sludge emptying and transport services operate, as well as the general lack of interest or visibility of the topic with influential stakeholders.

3.2.2.2 LEGAL FRAMEWORK FOR SANITATION AND FECAL SLUDGE MANAGEMENT

As mentioned in 2.3.8 the most important aspects of the legal framework that influence fecal sludge management are:

- Overall roles and responsibilities
- Regulation of customer behavior
- Regulation of customer emptying practices
- Regulation of the collection, transfer, treatment, re-use and disposal practices
- Financial flows

The first point has been addressed above, in this paragraph the other 3 aspects will be discussed, while some comments on financial flows will be given in the next paragraph.

Regulation of household behavior involves two main things: the construction of on-site facilities and the proper maintenance and emptying of these facilities. Building codes that include standards for septic tanks exist in all countries but are barely enforced. Whilst some could be more detailed, it is less clear who should be implementing these codes, whether there is sufficient capacity to do so and how they apply in areas which are not legally recognised. The Vietnam report mentions that even though correct designs may be submitted to the local Department of Construction, these are not always built in practice. Awareness among different stakeholders of the existence of guidelines for sanitation in the building codes also seems to be low. Where households are allowed to connect their toilets directly to drains or small bore sewers, similar design standards are necessary to prevent blockage and flooding.

Methods of regulation of the emptying frequency or discharge of effluent by households is less clear except where scheduled desludging has been applied. Environmental regulation generally prohibits discharge of harmful substances either in open ground or in watercourses, but regulation often does not explicitly mention human waste or provide clear means of ascertaining the source and extent of fines. Implementation of pollution legislation therefore depends on interpretation and leadership of the responsible agencies, something which is often lacking. In addition, many of the customers and businesses surveyed noted that until and unless the responsible authorities provided alternative affordable solutions for discharge or disposal it was unreasonable for such regulations to be enforced.

The city centre of Hai Phong, and until recently Peninsular Malaysia, practice scheduled desludging. Households simply get a notice when desludging is due and receive a certificate confirming they have complied. Under the new Water Industry Services Act of Malaysia, scheduled desludging is no longer practiced, but the Act does state the duty of owners to “ensure desludging of septic tanks so that it will not cause a nuisance and/or threat to public health.” The new Act even leaves the opportunity for government enforced desludging intervals by saying that: “The owner also has the duty to carry out desludging at intervals as may be prescribed in regulations by order of the Minister.” To implement this, SPAN maintains a database of all on-site facilities and sends out reminders to

customers. Clearly such an approach only works where all customers have some degree of formal land occupancy, whether as tenant or landowner.

Registration of emptying businesses is limited in all countries except Malaysia where 4 types of permits or licences are required to operate a FSM business. Permits are required in Cambodia and Vietnam, but again in Cambodia this is not practiced, while in Vietnam this is only the standard business license. An exception is HCMC where emptiers are required to register at the District office of Natural Resources and Environment.

Although environmental or solid waste legislation could cover disposal of fecal sludge, often the rules are not explicit and FS is an institutional 'orphan'. Fines for illegal dumping apply in Vietnam, Cambodia and India, but enforcement is difficult.

In summary, except in Malaysia, authorities have little or no control over who enters the market and are unable to regulate the quality of services provided. Except for imposition of fines, there is little control over illegal dumping by emptiers. This is further complicated by the fact that in Cambodia and Vietnam the responsible agencies are also engaged in the market themselves.

The legislation related to the treatment of sludge and discharge of effluent from treatment plants generally falls under the Ministry of Environment. Environmental impact assessment before the construction of treatment plants is not uncommon. However, in the absence of treatment plants, sludge is also disposed at landfills or dumping sites which are less regulated. Vietnam is working on guidelines regarding the compositing of human waste, led by the Ministry of Health in collaboration with the Ministry of Construction. Operation of treatment plants and landfills is usually done by government companies, but there is little information in the country reports on regulation of treatment and re-use of sludge.

3.2.2.3 FINANCE OF THE SANITATION SECTOR

Only in Malaysia, and to a certain extent in Vietnam, has fecal sludge management been integrated into the finance flows of the sanitation sector. In Bangladesh, India and Cambodia, fecal sludge emptying businesses are informal and the only relevant financial flows are between the household, the FS emptier and in some cases the receiving disposal sites (only the Cambodia report noted payments for disposal by emptiers though it is suggested or inferred in other documents). The surcharge on the water bill in Phnom Penh ("sewerage charge") appears to be for the operation of the sewers, drains, pumping stations and so on whilst surcharges on water bills have been applied in some Vietnamese cities with varying support, conviction and success.

Visualisations of the financial flows of Hanoi (public and private operator) are provided on the following page. The other countries have not done this kind of analysis. Cross-subsidy of FS operations of public companies through other sources of income is necessary in all three cities in Vietnam, as well as in Malaysia.

Figure 11: Flow of money chart for FSM transactions at Hanoi URENCO (public company)

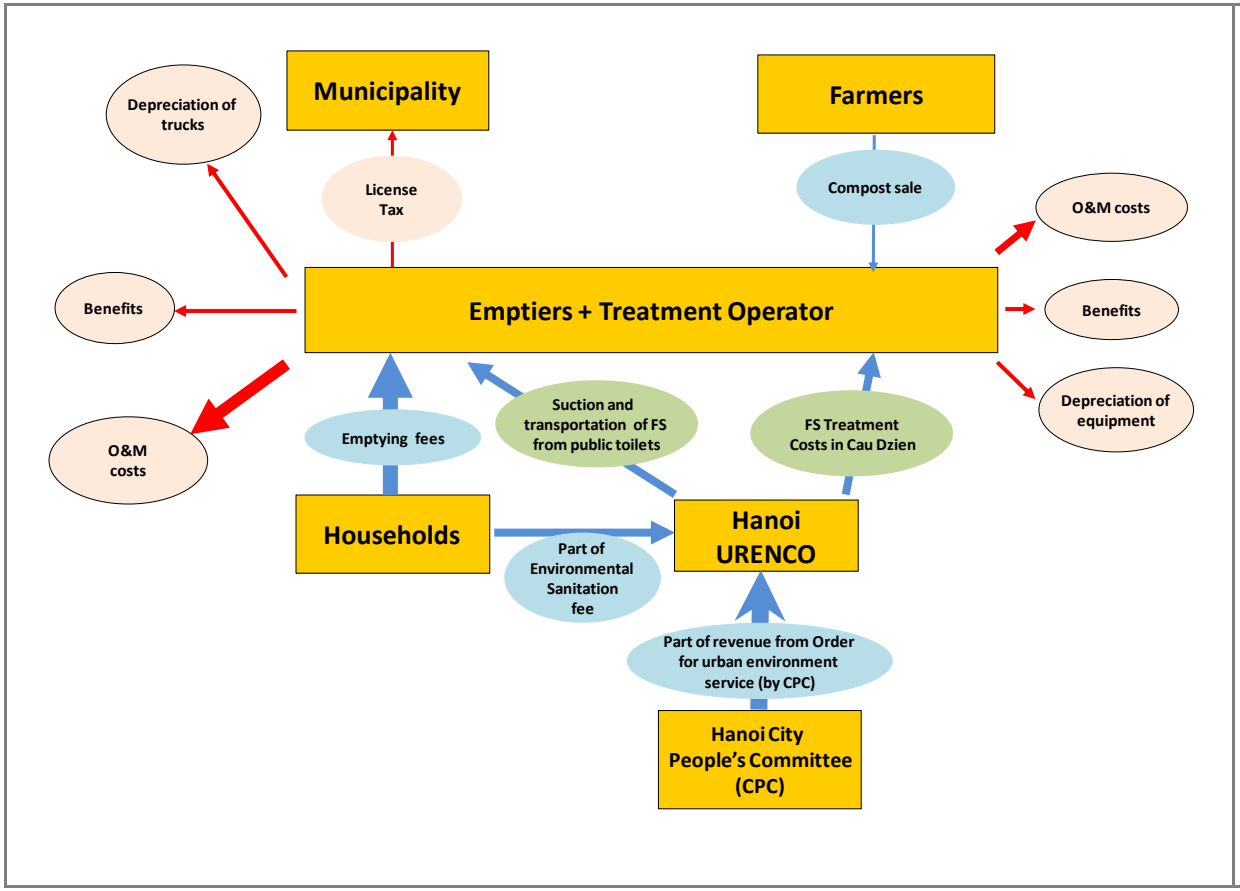
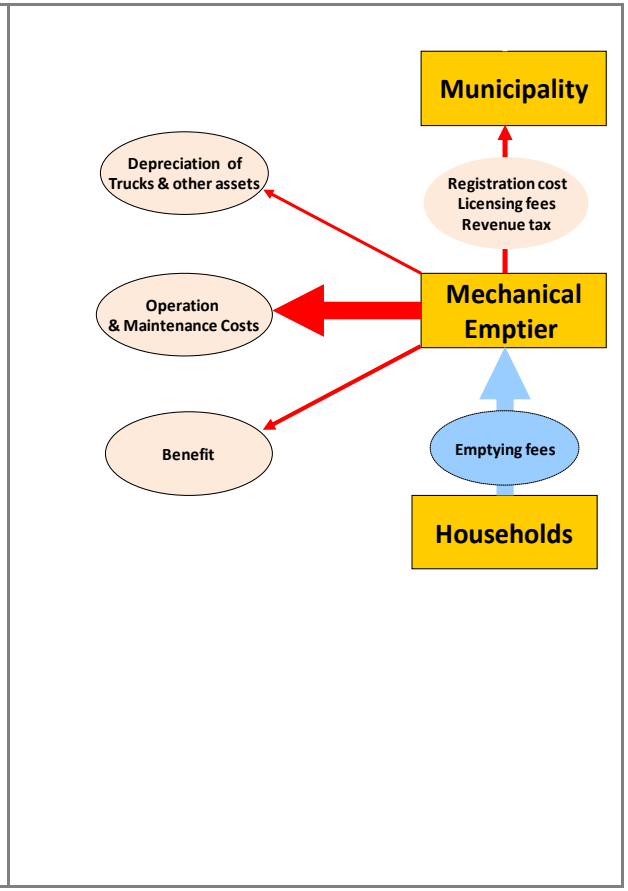


Figure 12: Typical flow of money chart for FSM transactions at private enterprise



3.3 HOUSEHOLD SURVEY RESULTS

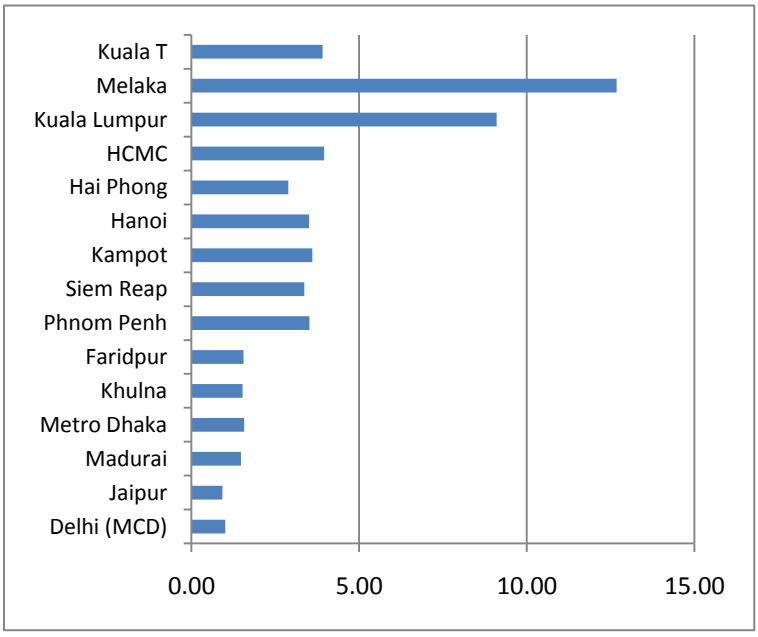
3.3.1 DEMOGRAPHIC SITUATION IN THE SELECTED SURVEY AREAS IN THE 15 CITIES

From this point onwards, the report focuses on the situation in the selected survey areas of the cities. Table 9 shows the size of the survey areas within the 15 cities. While in Khulna, Faridpur and the Cambodian cities the sample is representative for the whole city, in the other cities the survey area represents the part of the city with higher incidence of on-site facilities. This means that the percentages of on-site facilities as well as the emptying frequencies are higher than would be expected for the whole of the city.

Table 9 Size of the survey areas within the selected cities

City	size survey area (hh)	% of total city population	household size- in survey	literacy
Delhi (MCD)	424,857	25%	6.0	99%
Jaipur	101,714	20%	7.0	93%
Madurai	35,873	16%	5.0	96%
Metro Dhaka	333,747	10%	5.2	
Khulna	384,169	100%	5.3	
Faridpur	25,342	100%	5.2	94%
Phnom Penh	270,942	100%	4.9	
Siem Reap	34,421	100%	4.9	98%
Kampot	7,922	100%	4.9	
Hanoi	489,362	81%	4.7	
Hai Phong	232,760	93%	4.1	
HCMC	1,540,938	79%	4.8	
Kuala Lumpur	58,252	13%	5.1	95%
Melaka	44,338	36%	5.1	95%
Kuala T	57,109	82%	5.3	95%

Figure 13 Average income per Capita per day in the selected survey areas (in USD)



(Note: the size of the survey population for Dhaka, and the three Vietnamese cities seems to be an estimate.)

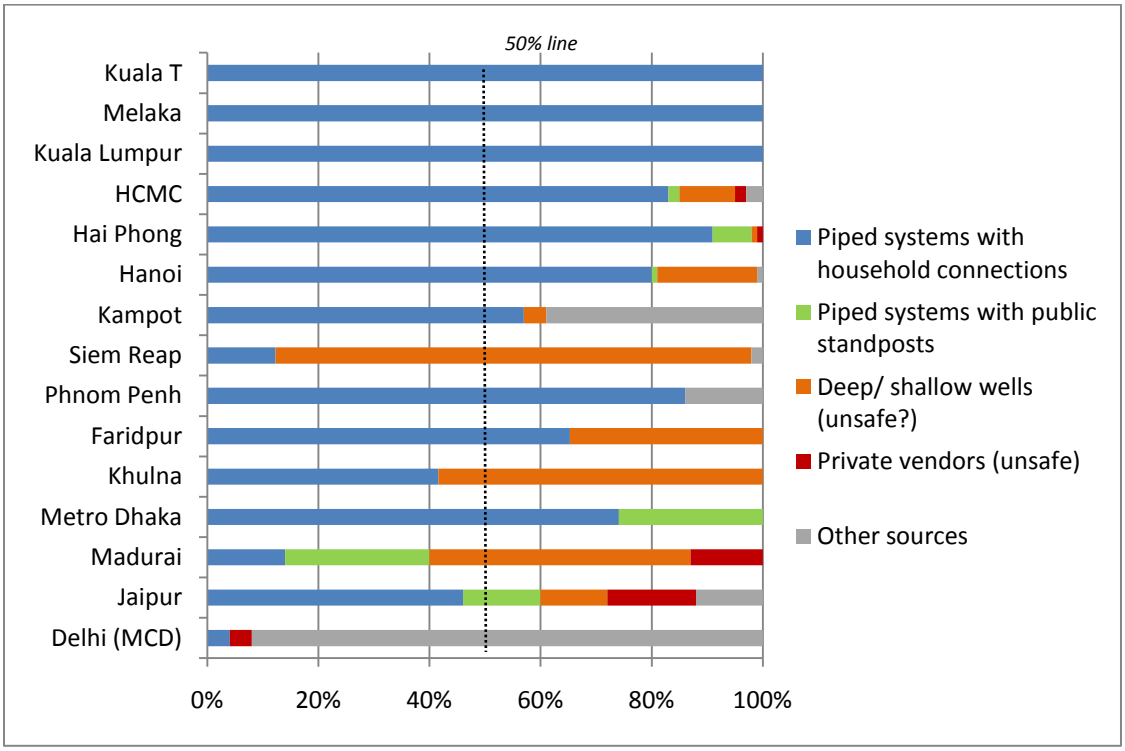
For reference, average household size and literacy rates in the survey areas have been added to this table.

There is quite some variation in average income and per capita income between the survey areas, as can be seen in the table on the left. When looking at this, it should be taken into consideration that the survey areas in Delhi and Dhaka are the poorer areas of the city.

3.3.2 ACCESS TO WATER SUPPLY AND SANITATION IN THE SURVEY AREAS

In terms of access to drinking water and the sources used, it can be observed in **Error! Reference source not ound.**, that the percentage of the household connections is relatively low in the selected survey areas in Cambodia, India and Bangladesh (with exception of Dhaka and Phnom Penh). Though the data on wells are not detailed enough to conclude that all are unsafe, it is clear that this form of access is unregulated and likely to be unsafe. This means that improved access as by the JMP definition, is likely to be less than 50% in the surveyed areas in Siem Reap, Khulna, Madurai and Delhi. In Kampot and Phnom Penh, 24% and 14% of the households respectively have household connections to a privately managed piped water system. Though this might well be safe water, these households are included in "other sources" in this graph. The "other sources" in Delhi and Jaipur are the utility tankers and wells.

Figure 14 Access to water supply in the survey areas in % of the total population



There are no data on water consumption among the surveyed population of all 15 cities, so the only conclusion here is that public standposts, wells and water vendors generally result in lower per capita water consumption and less production of grey water.

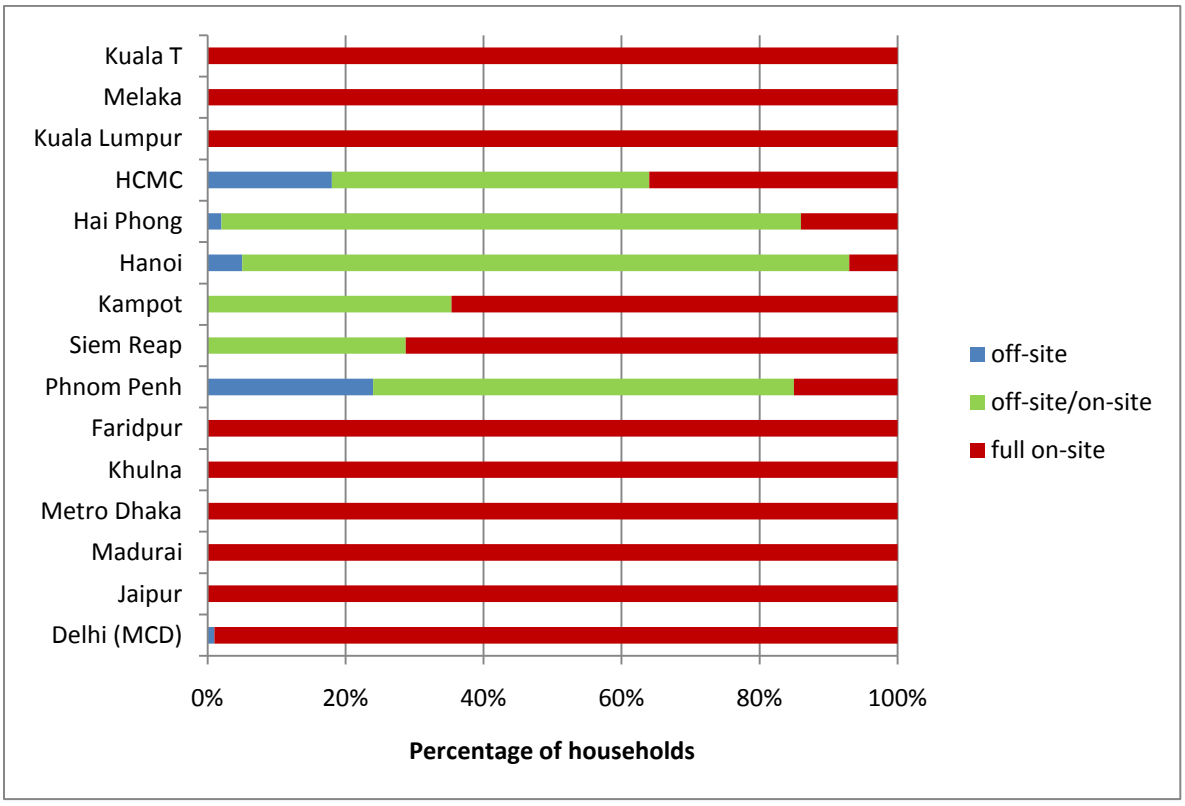
Open defecation is limited in the surveyed areas, but again there is not sufficient information to conclude which part of the population has access to improved sanitation. In urban areas it is often difficult to distinguish clearly between open defecation and shared facilities, so there may be overlap in the data presented for these categories in table 10 on the next page. The sharing of facilities for the Vietnamese cities actually refers to the shared facilities in apartment blocks.

Table 10 Open defecation and shared facilities in the surveyed areas

city	Delhi (MCD)	Jaipur	Madurai	Metro Dhaka	Khulna	Faridpur	Phnom Penh	Siem Reap	Kampot	Hanoi	Hai Phong	HCMC	Kuala Lumpur	Melaka	Kuala T
Hanging latrine or no latrine	2%	7%	3%	1%	1%	2%	3%	12%	12%	1%	1%	1%	0%	0%	0%
Shared facilities	24%	?	?	38%	38%	16%	?	6%	?	*10%*	*5%*	*8%*	0%	0%	0%

Graph 15 shows the off-site and on-site sanitation distribution among the survey population. Note that the off-site sanitation facilities include both direct connection to sewers as well as direct connection of toilets to drains or solids free/ small bore sewers, while the on-site/ off-site facilities typically are a septic tanks or pits connected to drains or small bore. Full on-site facilities are not connected to any sewer or drainage network. Of course, effluent from septic tanks still contains dangerous pathogens and should be going into a leach field or soak pit. No data have been collected on effluent disposal however. From anecdotic evidence it appears that the use of soak pits is uncommon and that in most countries effluent of the full on-site systems drains to streets.

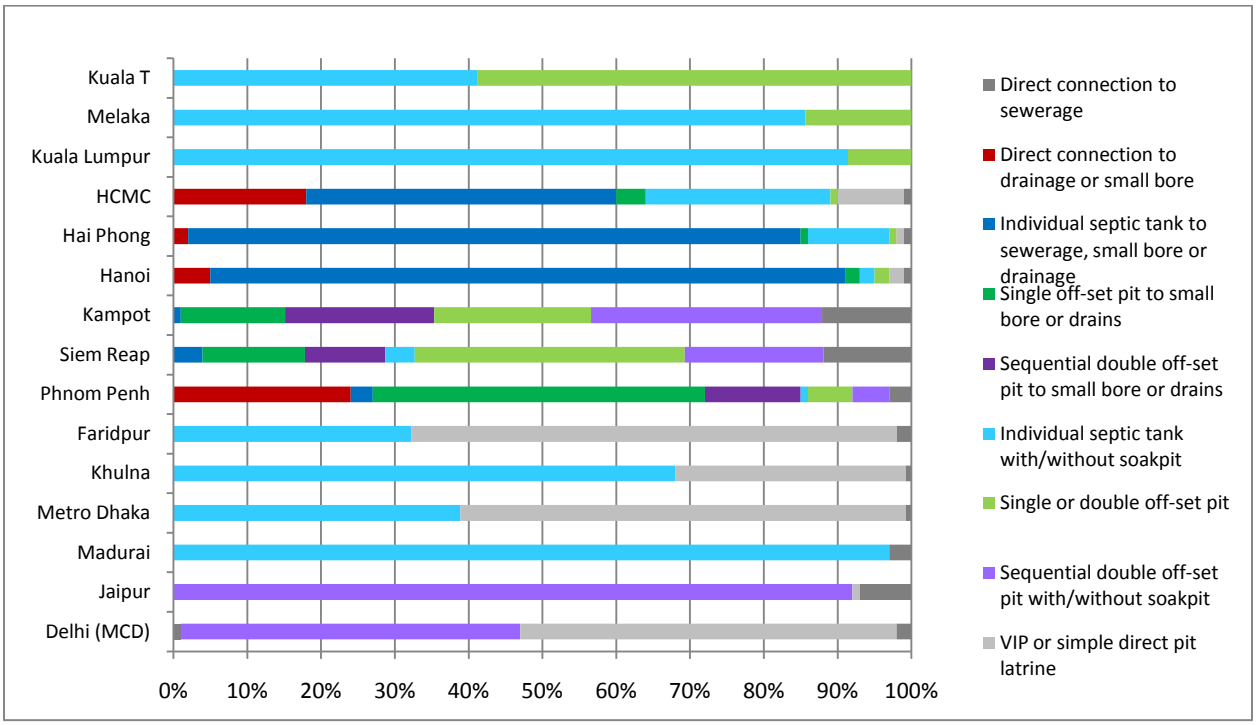
Figure 15 Distribution of on-site and off-site facilities in the survey areas



As can be seen in graph 15, survey areas in India, Bangladesh, Vietnam and Malaysia have been selected for a high incidence of on-site facilities, while in Dhaka a minor percentage of the households in the survey areas connects directly to drains. In Faridpur there is no drainage system, while in Khulna, Jaipur and Madurai no distinction has been made in the data between tanks and pits connected to drains and not connected to drains. It may be that the

actual percentage of off-site/ on-site in the survey areas of those cities is higher. Of course both categories (off-site/ on-site as well as full on-site) require emptying.

Figure 16 Distribution of different types of sanitation facilities in the surveyed areas



A more detailed overview of the access to different sanitation facilities of households in the survey areas can be seen in graph 16.[20] This follows the classification given in section 2.3.3. The presented figures are an interpretation of the data given by the countries on different facilities, as no uniform classification was used. It does however give an indication of the diversity of sanitation facilities and this does not yet take into account the diversity in sizes of the different on-site facilities. Also, it is likely that India and Bangladesh would have shown more diversity if a detailed classification would have been provided. Average sizes of pits among the countries range from 1.25 m^3 in Jaipur or Hanoi to 3.21m^3 in Khulna, while septic tanks range from 1.6 m^3 in HCMC to 19.82 m^3 in Faridpur. However, this obscures in-country variation. For example, pits in the survey area in Delhi have sizes of 7m^3 (30%), 3.88m^3 (30%), and 1.15m^3 (40%), while septic tanks have sizes of 1.72m^3 (60%) and 2.6m^3 (40%)

[20] In Vietnam the use of pre-treatment at household level is compulsory considering the low off-site treatment capacity. Even though these may be connected to sewerage systems, in the graph they have been classified under the individual septic tanks connected to sewerage, small bore or drains. Also holding tanks have been classified as "single or double off-set pit" considering that these are not water tight.

Table 11 Number of households that need pit or tank emptying

city	size survey area (hh)	% requiring emptying services	hh requiring emptying services
Delhi (MCD)	424,857	97%	412,111
Jaipur	101,714	93%	472,971
Madurai	35,873	97%	217,483
Metro Dhaka	333,747	99%	331,177
Khulna	384,169	99%	381,211
Faridpur	25,342	98%	24,840
Phnom Penh	270,942	73%	197,788
Siem Reap	34,421	88%	30,290
Kampot	7,922	88%	6,971
Hanoi	489,362	94%	460,000
Hai Phong	232,760	97%	225,777
HCMC	1,540,938	81%	1,248,159
Kuala Lumpur	58,252	100%	58,252
Melaka	44,338	100%	44,338
Kuala T	57,109	100%	57,109

As mentioned, these data are an interpretation of the information given in the reports and other related data provided by the research teams. Based on the description of the "septic tanks" in Jaipur and Delhi, it was concluded that these facilities basically fit the "sequential double off-set pit" as described in the Cambodia report and not the standard septic tank[21]. Also, so far no literature has been found to confirm that these sequential pits function as a septic tank as stated in the India report. In terms of health and environmental impact, it would be worthwhile to study the effluent of these different types of facilities.

The high proportions of direct pit facilities in Delhi (simple pits) and Bangladesh (VIP) should be a concern. While no detailed information has been collected on the quality of construction of these pits, it is not considered appropriate in densely populated areas, in particular when ground water sources are used for drinking (such as in Faridpur).

The diversity of pits and tanks, let alone the different dimensions of facilities, makes it very difficult to make a reliable estimation of the market size for fecal sludge management in terms of volume of fecal sludge. However, the data do allow the estimation of the number of households within the surveyed areas that need emptying (see table 11).

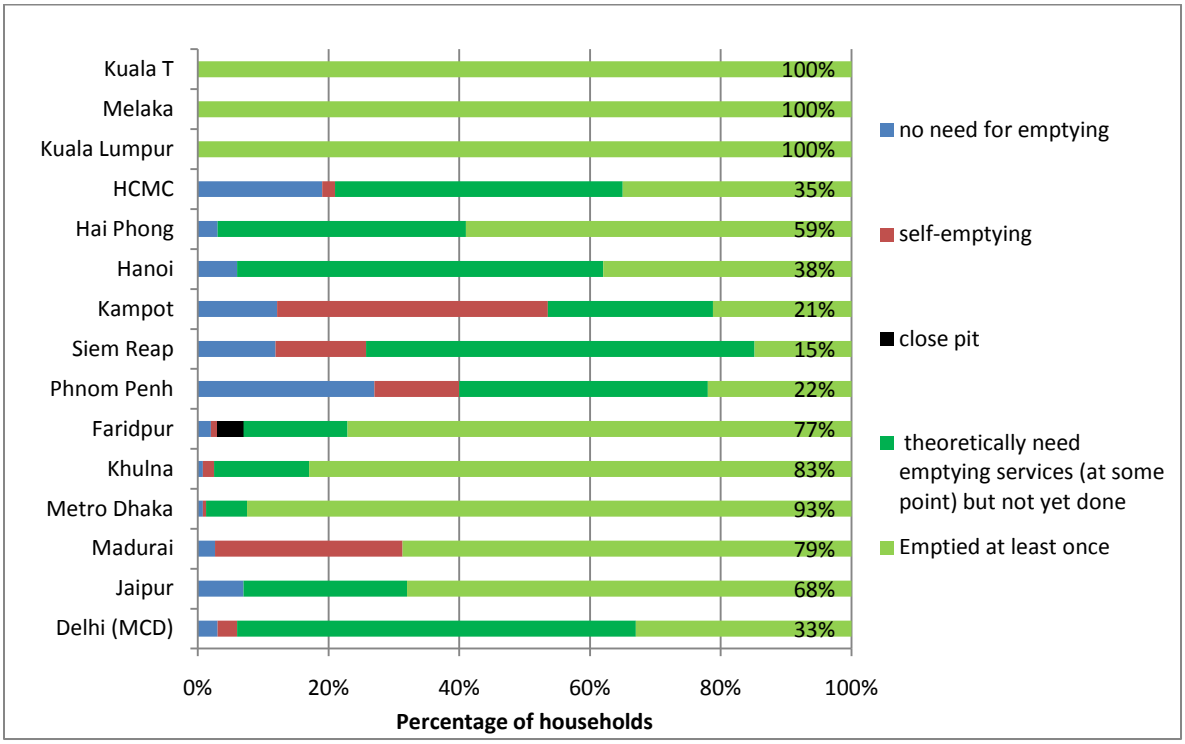
3.3.3 USE OF FECAL SLUDGE EXTRACTION AND TRANSPORT SERVICES

In the graph on the next page (Figure 17) , a comparison is made of the percentage of households that said they have emptied their tank at least once (light green) and the percentage of households that theoretically require emptying services at some moment but have not yet emptied their tanks/pits (dark green). As can be seen in the graph below, the percentage of households that have not yet emptied their tanks/pits is quite significant in some cities. The exception is Malaysia, due to its history of scheduled desludging and stricter enforcement than the other countries.

[21] For Jaipur also a "single chamber septic tank" is mentioned, but no disaggregated data are given for the two types of "septic tanks". In the proposed classification in 2.3.3. single chamber tanks are categorized separately, not under septic tanks.

In part the difference can be explained by new houses being built, of which the facilities have not needed emptying yet. However, the percentages of annual growth of these cities make it unlikely that this scenario applies to so many people, even when taking into account that the survey areas are areas of high growth[22].

Figure 17 Comparison of % households in the surveyed areas that theoretically need emptying services and those who actually use services



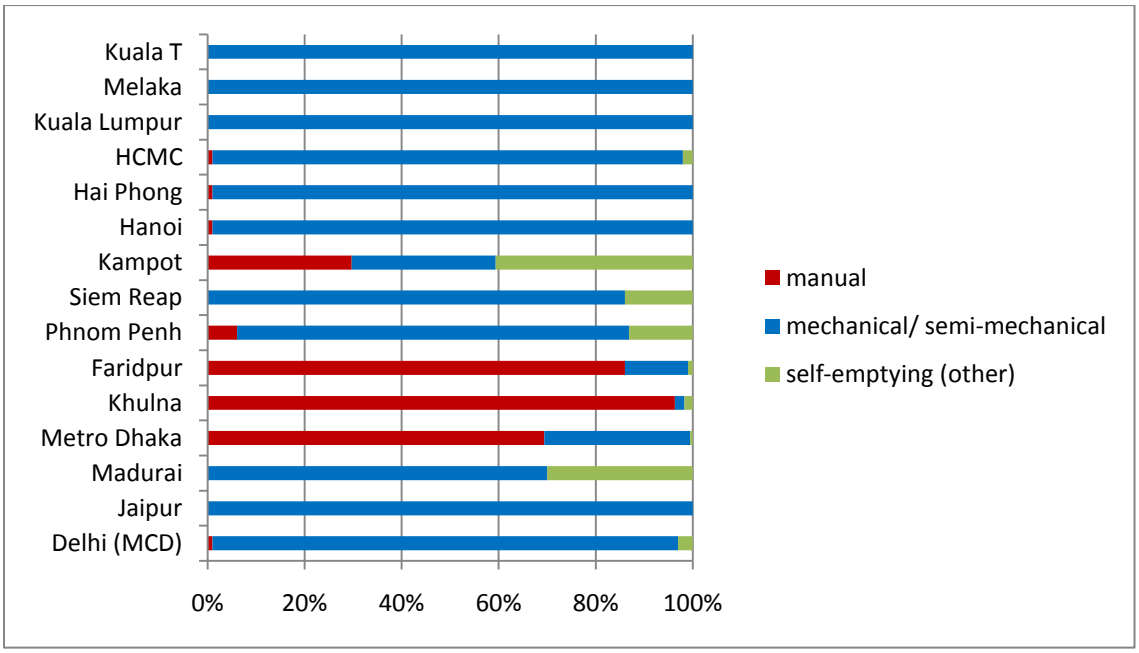
The relatively low rates of emptying of collection facilities exists in spite of high awareness about the health links in Delhi (91% awareness of health links) and Siem Reap (97% awareness of health links).

As can be seen in the Figure 18, except for Bangladesh and Kampot, emptying is predominantly done mechanically. In Kampot, the emptying fee for manual services (USD 20) as compared to mechanical emptying (USD 45) is the reason for continuing use of manual services. In Bangladesh, lack of awareness and information about the existence of mechanical service providers is given as a reason, as well as the high costs of mechanical providers compared to manual providers.

In Vietnamese cities a combination of manual and mechanical services is used if accessibility of tanks or pits is a problem. Besides these exceptions, it is clear that for most countries, the potential market is for mechanical services. The category of "others" refers to emptying with help of family members or other relatives.

[22] For example consider a recommended desludging frequency of 5 years. The annual growth rate in Cambodia is 1.7%, which would amount to a population growth of approximately 8% in the past 5 years. That is 8% new population that may not have emptied its pit/tank, which is quite remote from the 38% in Phnom Penh who said they have not needed to empty their tank yet. Similarly for Faridpur, 5 years would give 6% of new population, whereas in Delhi the current population growth would lead a 20% new population within a period of 5 years.

Figure 18 Percentages of households using manual, mechanical and self-emptying to empty their pits/ tanks

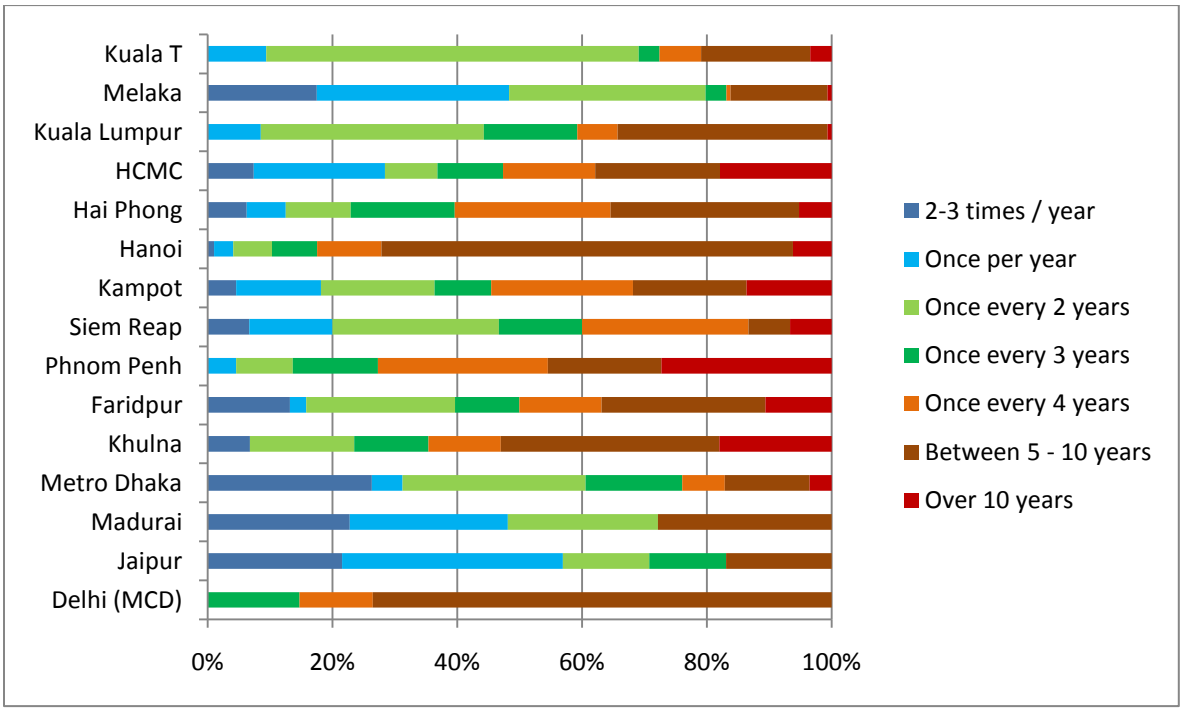


In addition to the percentage of households that use emptying services to empty their tanks or pits, the size of the market for fecal sludge emptying services depends on the frequency with which facilities are emptied. This allows an estimation of the percentage of households that empty their pits and tanks in any given year. Malaysia defines this as the "acceptance rate" of desludging services.

In the next graph the emptying frequencies of the households in the surveyed areas can be seen[23]. Once in every 3-5 years is considered a recommended interval for most tanks. In 7 survey areas, the emptying frequency of more than half of the households exceeds three years.

[23] It is assumed that the relatively higher emptying frequencies in Dhaka reflect a bias in the selection of households during the survey.

Figure 19 Tank/ pit emptying frequencies of households in the survey areas



Combining this information results in the following acceptance rates for the 15 cities (see Figure 20). The higher values in Dhaka, Madurai and Jaipur relate to the fact that these cities have higher percentages of households whose facilities need emptying 2-3 times a year. There is no correlation with the size of facilities though. In table 12 below the average pit sizes for the different cities can be observed. Though sizes of pits and tanks in Bangladesh and India are relatively larger, emptying is done more frequently.

Table 12 Average sizes of pits and septic tanks in the different survey areas

In m^3	Delhi (MCD)	Jaipur	Madurai	Metro Dhaka	Khulna	Faridpur	Phnom Penh	Siem Reap	Kampot	Hanoi	Hai Phong	HCMC	Malaysia
pits	2.07	1.25		3.17	3.17	3.21	1.75	1.68	1.63	1.3	1.5	1.5	1.5
septic tanks	3.71	4.4	2.7	14.41	14.41	19.82	2.50	2.00	1.90	2.6	1.9	1.6	2

It is important to keep in mind that, the acceptance rate only gives an impression of the size the market for FS emptying services for two reasons:

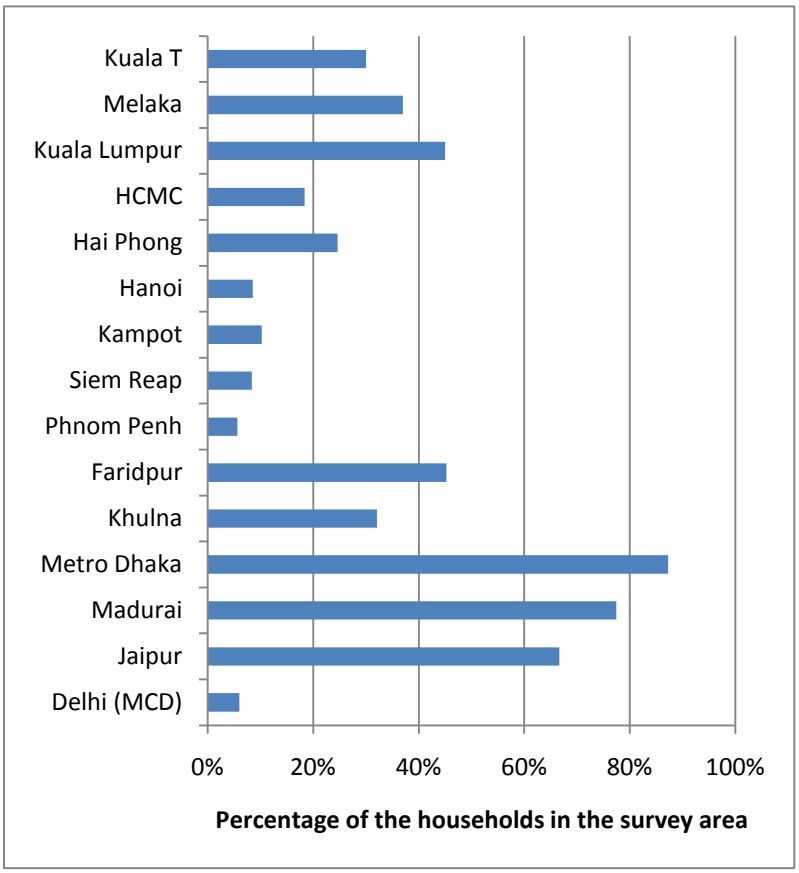
1. The emptying frequencies are for self-emptied and externally emptied facilities combined. It is highly likely that the households who have to empty their facility more frequently, have a smaller facility and a higher incidence of self-emptying can be expected among these households.

2. The acceptance rate has not been corrected for shared facilities, which are very common in Bangladesh.

Furthermore, the acceptance rate expressed in % of households or clients, does not give the total volume of fecal sludge to be emptied. Tank or pit size varies greatly and an even distribution among frequency classes seems

highly unlikely. Trying to accommodate for these various issues, in the market analysis section the total volume of sludge produced and emptied in the different countries is presented.

Figure 20 Acceptance rate of FS emptying services



Besides the different shortcomings in the data, it is interesting to see how the acceptance rates vary explained either by a smaller population using on-site facilities or by lower emptying frequencies as shown in the previous page, or both. There is not enough information to explain low emptying frequencies. It appears that when households have the possibility to discharge in drains, they will use less or no emptying services. However, this is just a hypothesis.

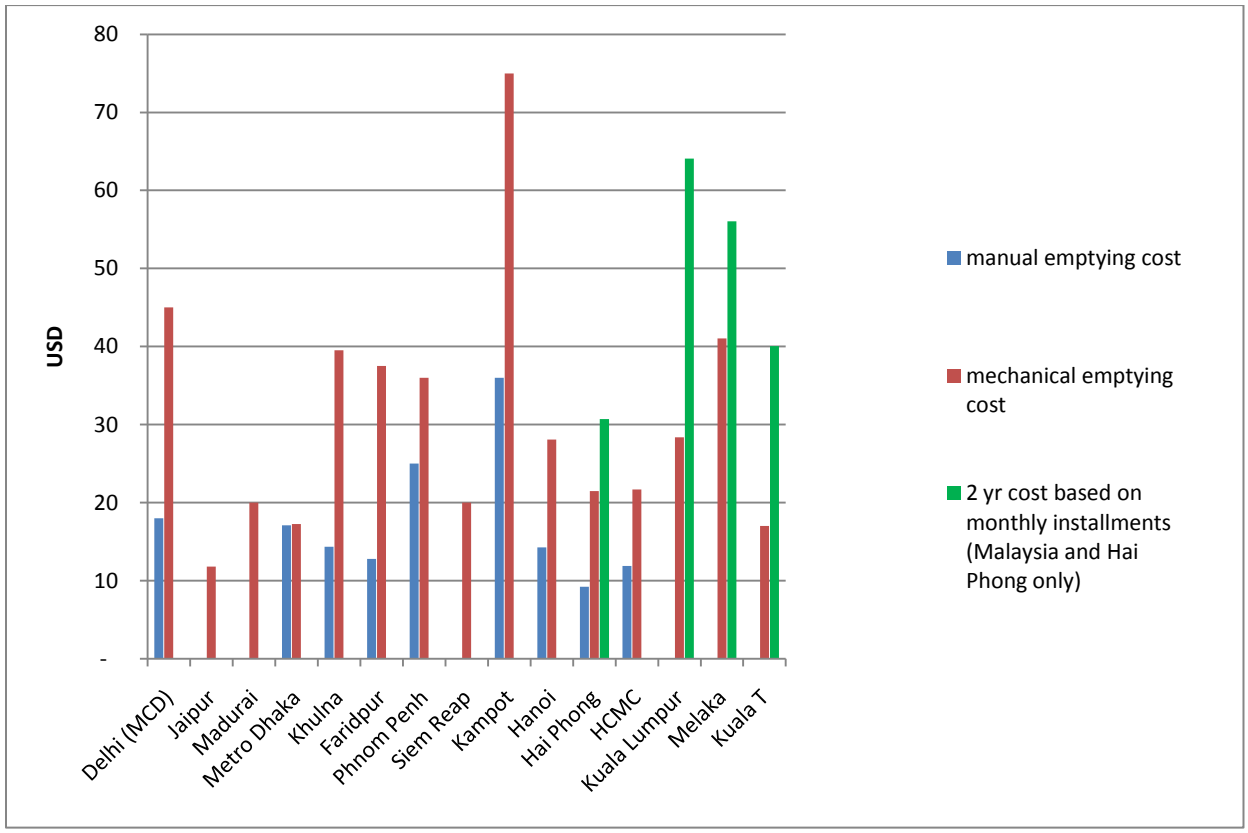
For a full understanding of the factors explaining why, how and when households empty their tank while others don't, a more in depth doer/ non-doer analysis or customer analysis should be done. Besides factors such as awareness, willingness to spend money, enforcement, and a lack of knowledge of when tanks require emptying might also play a role.

3.3.4 Emptying fees and customer perspective on the fecal sludge extraction and transport services

In all cities, except the Malaysian cities and Hai Phong, contacting and agreement for services is done ad-hoc and the payment is a one-time payment. In Malaysia part of the payment is done in installments and in Hai Phong payment is included as a surcharge in the water bill. Though there is also a surcharge on the water bill in Cambodia, that does not pay for the emptying services.

In Figure 21 the costs of emptying in the different cities are given. For Hai Phong only the demand-responsive service has been included. The graph shows clearly that in all cities reported costs of mechanical emptying are much higher than manual emptying costs. The exception is Dhaka, where the cost of mechanical emptying is subsidized by the NGO. As seen earlier, this does not result in a predominant use of manual services in the different cities, with the exception of Bangladesh. An additional issue in Bangladesh is that the household reported costs of mechanical emptying are about 3x as high as the fee appearing in the income statement of the municipality. The reason appears to be corruption by the emptying staff.

Figure 21 Cost of emptying per service in USD

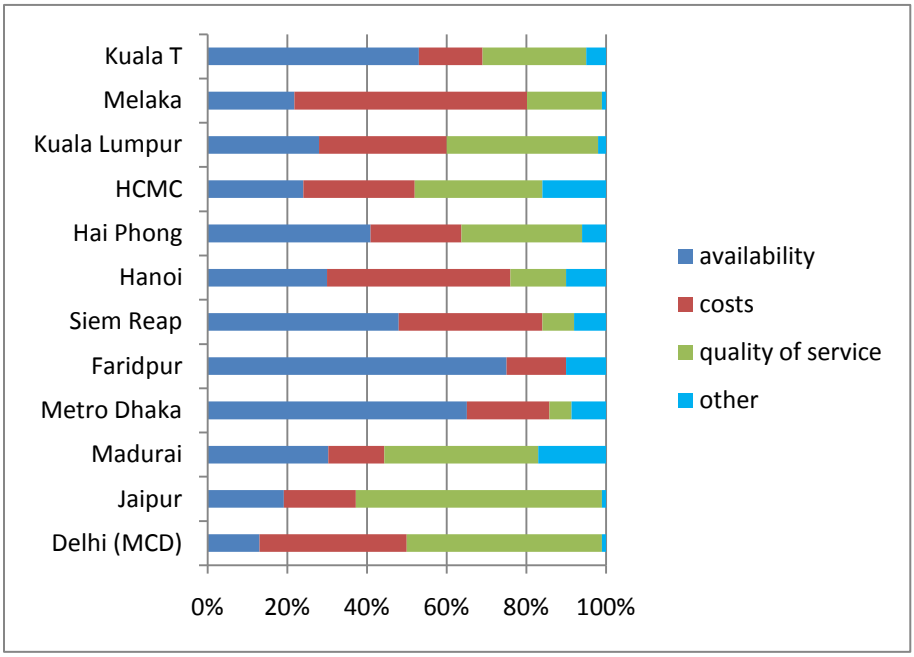


The costs for scheduled desludging in the Malaysian cities was given as 2.67 USD/month, 2.34 USD/month, 1.67 USD/month for Kuala Lumpur, Melaka and Kuala Terrenganu respectively. Over a period of 2 years, this results in an emptying fee which is significantly higher than the demand-responsive fee. This may be a factor contributing to the households' reluctance to scheduled desludging.

Across the cities, household satisfaction with the current services is very high - around 90% are satisfied with both fees and service. Looking at criteria for choosing an emptying service, cost is not always the main concern (Figure 22). Availability is an important consideration in several cities[24]. This could be interpreted as an underdeveloped market both in terms of information to customers and marketing of services, as well as capacity. For the latter the seasonality of demand should be taken into account. Except for India and Kuala Lumpur, quality of service does not score very high as a consideration.

[24] Unfortunately there are no data from Kampot or Phnom Penh on this variable.

Figure 22 Primary consideration in selecting FS emptying services (in % of households)



When looking at annualized costs of emptying (assuming a 3 year frequency) compared to annual income, the expenses will be less than 1% of average annual income for all cities. However, this does not give a clear idea about affordability from the perspective of households. While emptying of tanks or pits is not a monthly expense for households, it is a one-time payment that most households will have to cover from their monthly budget. In evaluating this cost, they will also compare it to the monthly costs of other services.

Figure 23 Average expense of services as percentage of the average monthly income

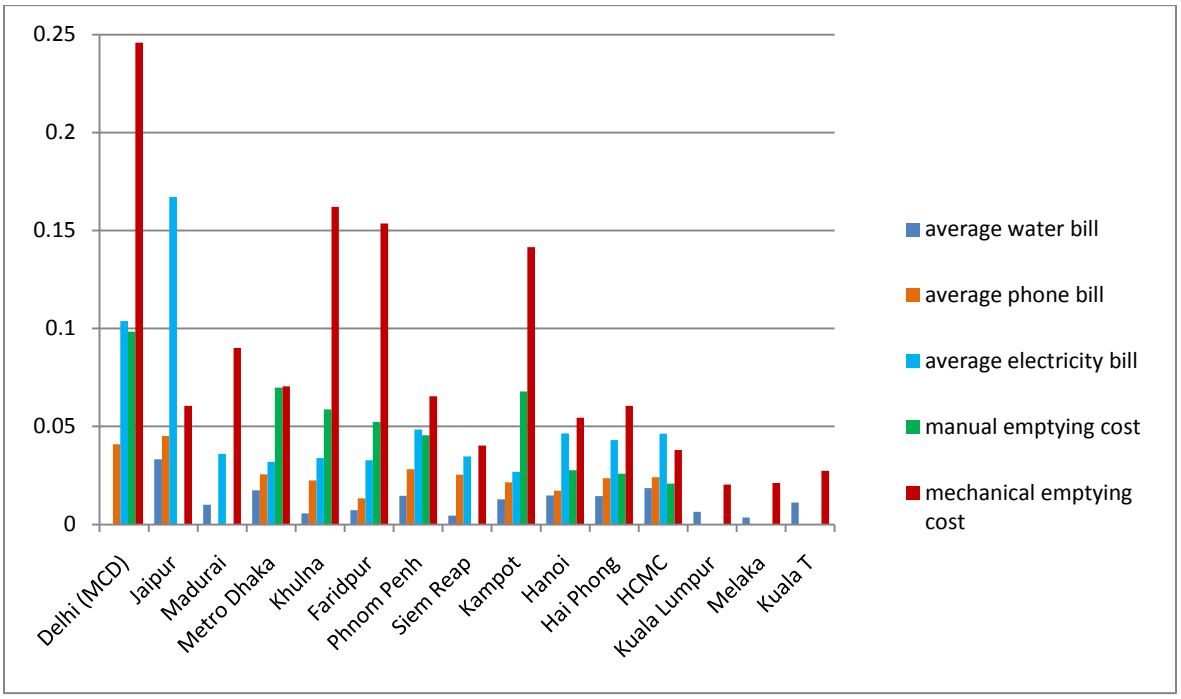


Figure 23 shows that while costs of other services rarely exceed 10% of monthly income, and mostly stay within the range of 1-3% of monthly income, fecal sludge emptying costs range from 2- 24% of monthly income. So it seems understandable that households will try to postpone or avoid this expenditure until there is an urgent need for emptying. This seems to be a strong argument in favor of payment in installments.

3.4 FECAL SLUDGE EMPTYING AND TRANSPORT BUSINESSES IN THE SURVEY AREAS

3.4.1 OVERALL EMERGING PICTURE OF FECAL SLUDGE EMPTYING AND TRANSPORT BUSINESSES IN THE SURVEY AREAS

The overall emerging picture is that the capacity for the emptying and transport services in India, Cambodia, Vietnam and Bangladesh lies predominantly with private businesses[25], both when looking at the numbers of businesses as well as the truck capacity in terms of m^3.

A total of 220 mechanical emptying businesses are active in these 15 cities[26] of which 205 are private. In spite of the lack of figures, it is clear that in Bangladesh manual emptying is prevalent, which is entirely private sector based.

Table 13 Percentage of private truck capacity as compared to total capacity

	% of existing truck capacity (in m^3)
Delhi (MCD)	59%
Jaipur	90%
Madurai	83%
Phnom Penh	100%
Siem Reap	100%
Kampot	100%
Hanoi	95%
Hai Phong	85%
HCMC	94%

While 15 of the mechanical companies are public, only the Vietnamese and Malaysian public companies engage in household emptying services. Public companies in the other countries concentrate on maintenance of the sewer/drainage networks (Cambodia, Bangladesh) and/or emptying services for government institutions and schools only (Delhi, Madurai). For these reasons, the public companies from those cities are not included in this review.

In addition to absolute numbers, the mechanical private sector also has the largest truck capacity, forming 59%-100% of the total truck capacity in m^3 (see table). As public emptiers in Delhi and Madurai only empty government institutions, its available capacity for emptying of households should be considered practically zero. This means that service to households in these cities relies on private sector capacity. In Malaysia there are also private businesses, but the main truck capacity lies with IWK[27].

Table 14 Number of households per active private company and per private truck

city	Delhi (MCD)	Jaipur	Madurai	Metro Dhaka	Phnom Penh	Siem Reap	Kampot	Hanoi	Hai Phong	HCMC
hh/private company	10,954	14,756	11,049	49,591	6,845	3,700	1,093	10,804	13,530	24,012
hh/private truck	10,954	11,261	11,049	49,591	4,195	2,775	1,093	5,207	3,157	8,122

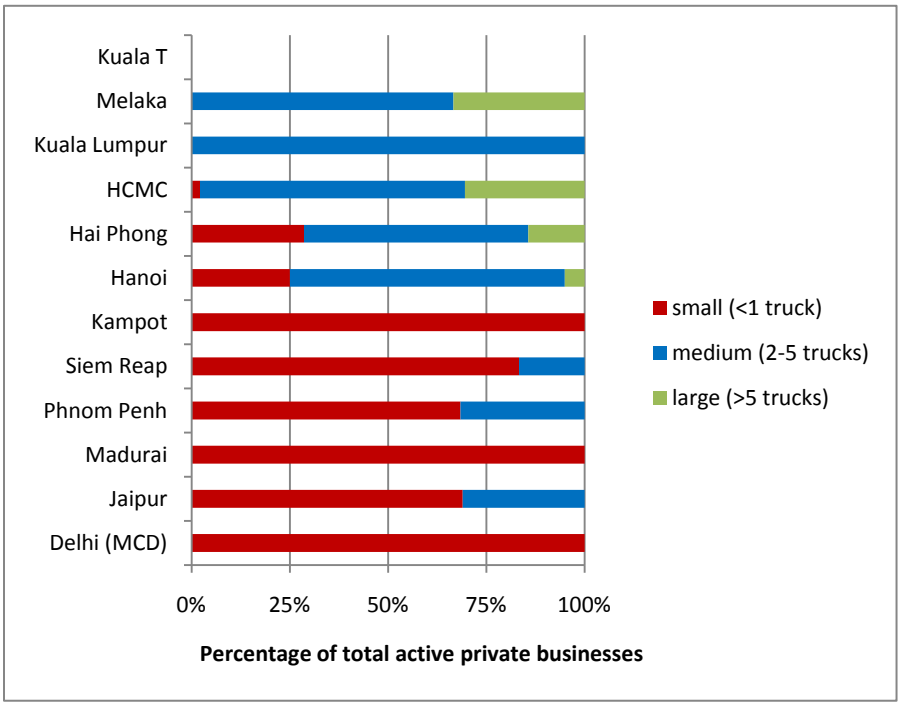
[25] It is not clear whether the interpretation of public or private has been uniform across the countries. For this reason, it is not clear whether the main capacity in Vietnam actually lies with the private sector. The Vietnam report gives several different numbers for the total of private businesses involved in the emptying, here the excel sheet has been used as a base.

[26] There is no reliable estimate of the total number of active manual emptiers. In Delhi alone there are over 1,000 and the Cambodia team identified 24 in Phnom Penh. However, no numbers have been given in the Bangladesh report.

[27] From the data it seems that IWK has been included as a private business, which makes it impossible to compare the capacity of IWK with the other businesses. Also the total number of private businesses given in different sections varies.

Table 14 shows the number of households per active private company and per available private truck in the cities. This calculation is based on the size of the population that theoretically needs emptying services and uses mechanical services in as well as the private truck capacity (compared to total truck capacity)[28]. As can be seen, availability of services is higher in Cambodia than in India for example.

Figure 24 Distribution of private FS businesses according to the number of trucks



Mechanical emptying businesses in this study have been classified as small, medium and large based on the number of trucks they have (1 truck = small; 2-5 trucks = medium; >5 trucks = large). Under this definition, public companies are generally large, except for the two municipal companies in Bangladesh, (in Khulna and Faridpur). Among the private companies, almost 50% is small and 40% classifies as medium. The manual emptiers are considered to be small by definition[29].

In the above graph it can be seen that no large businesses exist in India or Cambodia, while in Vietnam and Malaysia the percentage of large companies is very limited.

For the 80%-90% of businesses in India and Vietnam, FS emptying and transport is their main business, but in Cambodia only half of the businesses consider it as their main activity. One of the reasons is the competition among businesses. In Malaysia 23% of private businesses has another activity as their main business. The diversification strategy in Malaysia has been a response to a decline in demand following the change over from scheduled to demand-responsive emptying. Manual emptiers in Bangladesh engage in a variety of activities besides emptying of tanks and pits.

Motivation to set up emptying businesses is for profit, though in India Dalits are mainly involved in the mechanical emptying who have an additional motivation of getting out of traditional manual scavenging activities. The aspiration for many is to diversify into other types of businesses. There are not many business people from other sectors entering the FSM market in India. In Cambodia and Vietnam, FSM businesses are often set up by former

[28] Figures are only indicative, because average numbers of trucks and truck capacity have been used to calculate this. Moreover, figures from Dhaka are considered unreliable. Also, this calculation does not include the reported emptying frequencies in the household survey.

[29] No cases have been found of medium sized manual emptying businesses, though some of the interviews in Cambodia suggest that there is a certain level of organization of manual emptying services through retailers in Phnom Penh.

employees of existing businesses (the URENCO's in Vietnam). In Malaysia, as the motivation is profit, private providers are not keen to accept business in remote areas or areas with difficult access. Instead such areas are serviced by IWK who is bounded by their concession. Female business owners are found in Cambodia, but none of the other countries reported on this. It is known that traditionally female scavengers are engaged in manual emptying in Asia, but the country reports do not include data on this.

The equipment used by manual emptiers is mostly only a bucket, a shovel and plastic drum for transport. Mechanical emptiers obviously need pumps and tanks. In table below some characteristics of the equipment of mechanical emptiers in the different cities and countries are given for illustration.

Table 15 Characteristics of the trucks used by mechanical emptiers in the cities

city	type of trucks	typical capacity (m^3)	capacity range (m^3)	Most trucks are new/second hand	value new	value 2nd hand
Delhi (MCD)	Tractors with tankers	3	2.5-5	new	16,500	7,500
Jaipur		3	2.5-6	new	12,500	6,818
Madurai	Mini-lorries mounted with tanks	5	3-6	new	15,555	
Metro Dhaka	Vacutug toed with a refurbished pick-up provided by the NGO	2	2	new	20,000	12,000
Khulna		2	2	new	20,000	12,000
Faridpur		0.6	0.6	new	20,000	12,000
Phnom Penh	Lorries assembled in country	5	5	2nd hand	20,000	15,000
Siem Reap		3	3	2nd hand	20,000	12,000
Kampot		5	5	2nd hand	20,000	15,000
Hanoi	A variety of truck types both assembled in country and imported	2.8	1-7.5	2nd hand	23,000-73,300	9,700-36,400
Hai Phong		2.5	1-7	2nd hand	77,700	22,800
HCMC		4.1	1-8	2nd hand	21,850	7,300-19,400
Kuala Lumpur	Specialised desludging trucks-assembled in Malaysia	4.5	2.5-11	aprox 42% new	98,000-130,000	57,000-93,000
Melaka		4.5	2.5-11	aprox 55% new	98,000-130,000	57,000-93,000
Kuala T		4.5	2.5-11	new	98,000-130,000	57,000-93,000

The table shows that truck capacity does not always correspond with average tank size in the area. An extreme example is Faridpur where the average size of a septic tank is 19.8m^3 according to data from the household survey, while the size of the mechanical emptying equipment is limited to 0.6m^3.

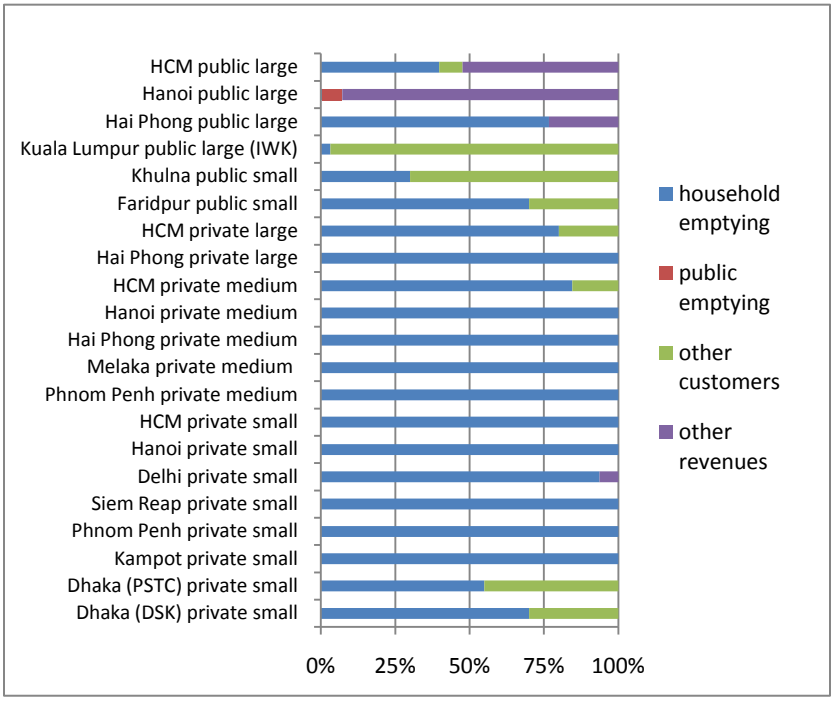
While private emptiers in India, Bangladesh and Cambodia can be considered informal, because the companies do not pay tax and are not registered, the private companies from Phnom Penh and Dhaka do pay for their truck licenses. Moreover, businesses in Phnom Penh pay environmental charges and in Siem Reap patent is paid at the beginning of the activity. In Vietnam and Malaysia companies are registered.

From the above it can be concluded that the main players in the FS emptying and transport businesses in these cities are small and medium private sector except in Malaysia where a large public company is the main player.

3.4.2 Revenues, expenses and profits of mechanical FS emptying and transport businesses

In this section the information from 21 income statements[30] is reviewed. It should be noted that the high variation in national contexts and types of businesses does not allow general conclusions about patterns or trends on the basis of these data only. The objective is simply to provide some insight into the nature of the FS emptying businesses. Income statements from manual emptiers have not been included in the analysis.

Figure 25 Percentage of revenue from different sources for the different businesses



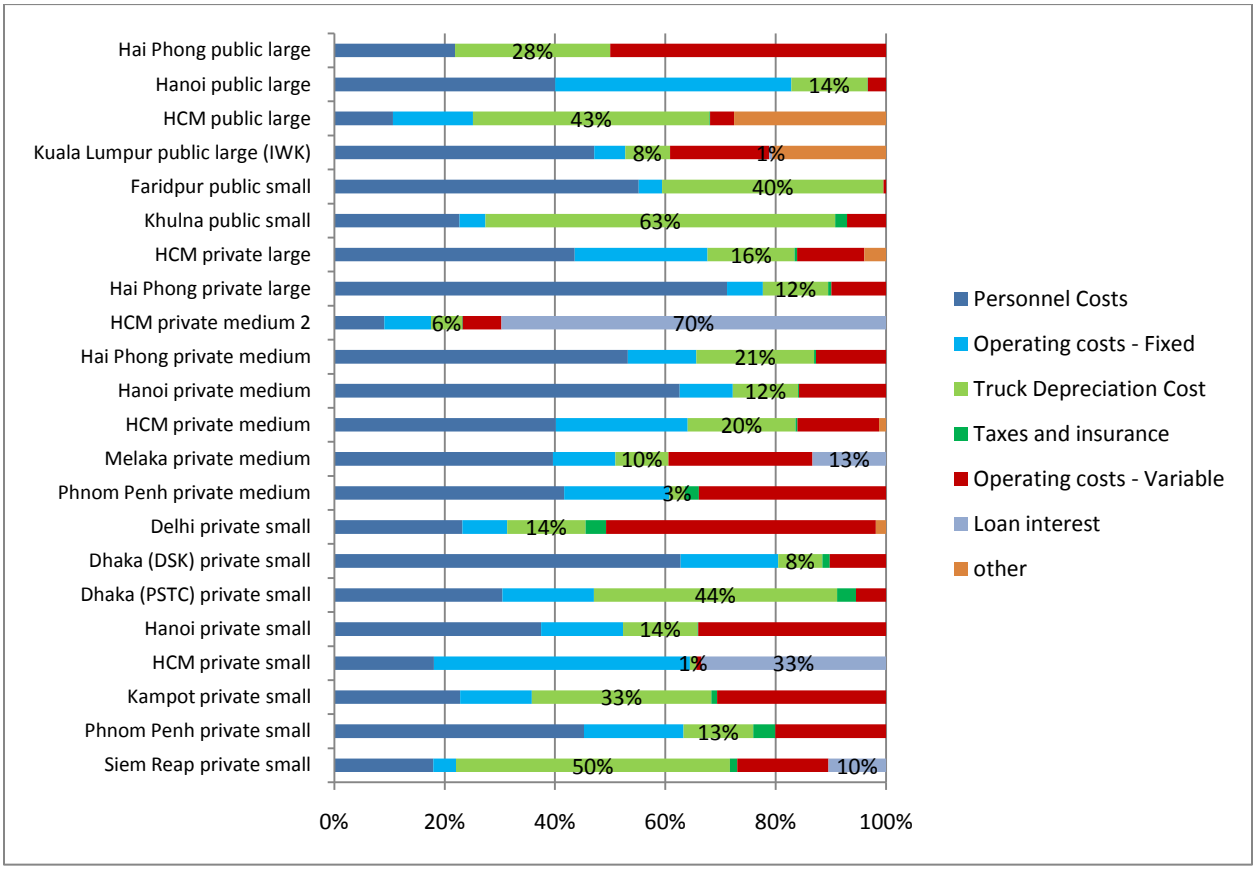
Though this study focuses on emptying and transport services for households, this is not the main source of revenue for all companies. As can be seen in the graph on different revenue sources, the large public companies in Vietnam rely mainly on other activities than FS emptying for their revenue. In HCM the revenues are from public toilet rent and in Hanoi the main income of the public company is from compost sales. In the case of Hai Phong, the company receives most of its revenue through a surcharge to the water bill (15%) that is meant to cover the costs of household FS emptying, but it also gets a significant portion from other services. The other companies get almost all their revenue from FS emptying, although a large number of companies (especially the public companies) get a significant part of this revenue from other customers than households. IWK's revenue, for instance, is mainly from commercial, industry and government institutions.

Income from commercial premises (restaurants, hotels and so on) are also important in some of the other cities (e.g. Siem Reap) but these have not been included separately in the income statements. The overall picture again confirms that emptying of household tanks and pits in India, Bangladesh, Cambodia and Vietnam is mainly done by the private sector, with public companies getting most of their revenue from other customers or activities. IWK in Malaysia forms an exception, where despite getting most of its revenue from other customers, it remains the main service supplier for households as well.

Seasonality of demand is an important factor in some of the cities at least. In India the peak season is during the monsoon and the off-season in the dry season. The difference in business in for example Delhi can be as much as 4-5 calls/day during peak season and 1 call/day in off- season. Business owners in Madurai mentioned that in off-season they receive 2-3 calls/week. Higher demand in the wet season is also mentioned for Phnom Penh.

[30] Most of the figures are based on averaged income statements (the averages are based on income statements for private business of similar size in the same city), but for Malaysia and Bangladesh, as well as the large public Vietnamese companies, the income statements of single companies were used.

Figure 26 Cost structure for different businesses



Regarding the cost structure of these businesses, as shown in Figure 26, no clear pattern can be found. It can be seen that depreciation of trucks is an important cost for almost all companies, but this does not correlate with profit. There is also a high variation in the percentages of flexible operating costs, but again no correlation with profit was found.

The "other" category for HCM's public company and IWK refers to expenses for their other activities as mentioned before.

IWK, the Vietnamese companies and some of the medium Cambodian companies have fixed personnel, while most of the small businesses have people on call who are paid a % of the emptying fee. Competition is a real issue in Madurai and the two larger Cambodian cities, leading companies in the latter cities to adopt full-time marketing staff and costs for marketing (leaflet distribution, telephone numbers being painted on poles and sign boards) can go up to 25% of all expenditure. In the above graph this is included under fixed operating costs. In Delhi however, competition is controlled by informal territorial agreements made among mechanical emptying businesses, and there is no marketing.

Though purchase loans are available in the market in all countries (in India for tractors), model income statements only reflect it for four companies. For Delhi it is mentioned that 75% of emptiers are partially financed by banks. The finance is only for the tractor under agricultural lending schemes.

Table 16 Comparison of key financial ratios

	Malaysia public large	Malaysia private medium	India private small	Vietnam private large	Vietnam private medium	Vietnam private small
NPV (USD)	33,441	- 5,562	7,158	70,492	77,326	13,682
IRR before tax	10%	8%	90%	485%	880%	80%
IRR after tax	9%	7%	65%	177%	116%	50%
5 year ROE	7%	3%	36%	21%	17%	18%
Companies analysed	1	1	15	2	12	2

An analysis of the key financial ratios of different existing businesses over a 5 year period shows that in most cases the businesses are profitable[31]. Only the medium company in Malaysia was found to have a negative net present value, while internal rates of return for both companies in Malaysia are found to be low. In India, 15 small companies were analysed, only one of which was found not to be profitable. In general the companies in Delhi were found to perform better than those in Jaipur or Madurai. In Vietnam the 12 medium companies analysed were found to perfom better than large and small companies in most cases, although considerable differences were evident between companies. In the case of the 2 large companies in Vietnam, the company in HCM performed much better than the company in Hai Phong.

The calculations of the economic figures presented above are influenced by the different economic rates used in each country, especially the different annual discount rates used. The consumer price index (CPI) influences the costs in subsequent years. The inflation rate is used to adjust the costs of wages, rents, and utility bills such as electricity, water and telephone, and higher inflation will result in higher costs and thus reduced profitability.

Table 17 Economic rates used in the countries' calculations

	Bangladesh	Vietnam	India	Malaysia	Cambodia
Inflation (CPI)	11%	11.8%	7%	n/a	n/a
Interest rate	n/a	18%	12%	4.5%	n/a
Discount rate (for NPV)	15%	18%	15%	8%	n/a
Depreciation of truck	20%	10%	20%	20%	15%

The interest rate determines the borrowing costs, with higher interest rates resulting in lower profitability. The discount rate is used to calculate the Net Present Value (NPV) of the project, which is an indicator of how much value an investment or a project adds to the firm over the projected period. Depreciation denotes the gradual decrease in the economic value of the equipment and capital assets of the company either through physical depreciation or obsolescence. Higher depreciation rates result in lower profitability.

In the case of Malaysia and India the results of the companies were found to be very sensitive to a small (5%) decrease in revenue or increase in operating costs[32]. This shows the vulnerability of these companies to market changes.

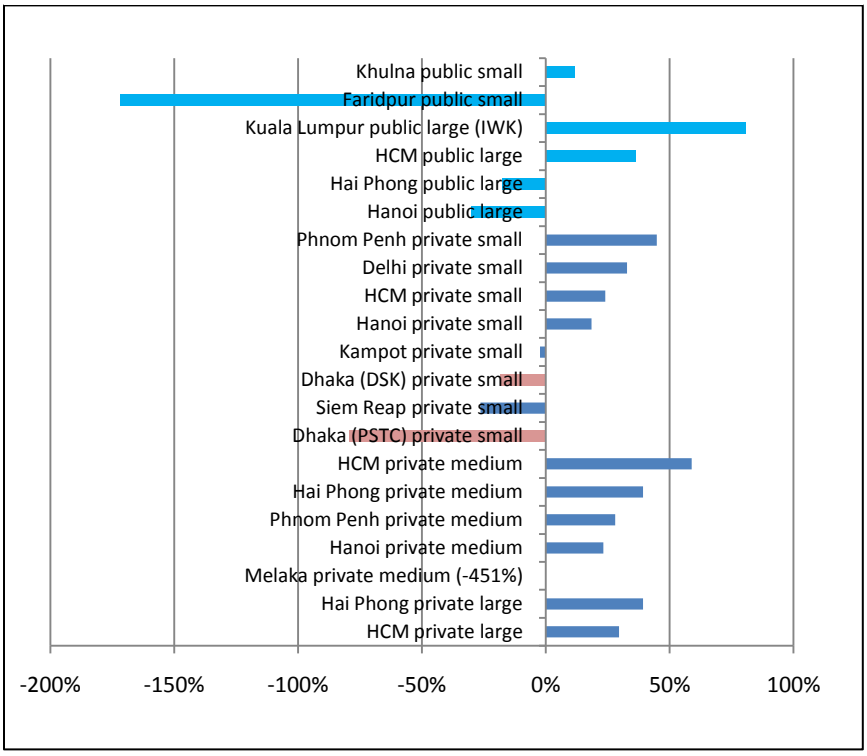
[31] For Cambodia the financial ratios were not provided, while in the case of Bangladesh the model presented was an adaption of an existing business model (this is treated in the next section). For Malaysia the financial ratios are provided for a single company, while for India and Bangladesh they form the average of the different companies analysed, according to their size.
[32] For the other countries no sensitivity analysis was included for existing companies.

Table 18 Sensitivy of selected Malaysian and Indian companies

	Malaysia public large	Malaysia private medium	India private small without loan	India private small with loan
IRR after tax	9%	7%	21%	43%
increase revenue 5%			33%	108%
decrease revenue 5%	2%	0%	9%	-1%
increase operating costs 5%	4%	2%		

As mentioned before, however, small and medium size companies generally give more weight to the return on sales (profit as a % of revenue). When reviewing these figures, most of the private FS emptying and transport businesses have made profit this year (see Figure 27.)[33]. When looking at the businesses that did not make profit it should be taken into account that the two small businesses from Dhaka are not-for-profit businesses that provide their services at a subsidized price to households in order to compete with manual emptying. Negative values for Melaka, Siem Reap and Kampot however indicate specific problems in these businesses. The private medium business in Melaka started business relatively recently and has high depreciation costs, while one of the explanations given for the negative values the Siem Reap and Kampot businesses is the limited size of the market in these towns.

Figure 27 Profit as percentage of revenue (before tax)



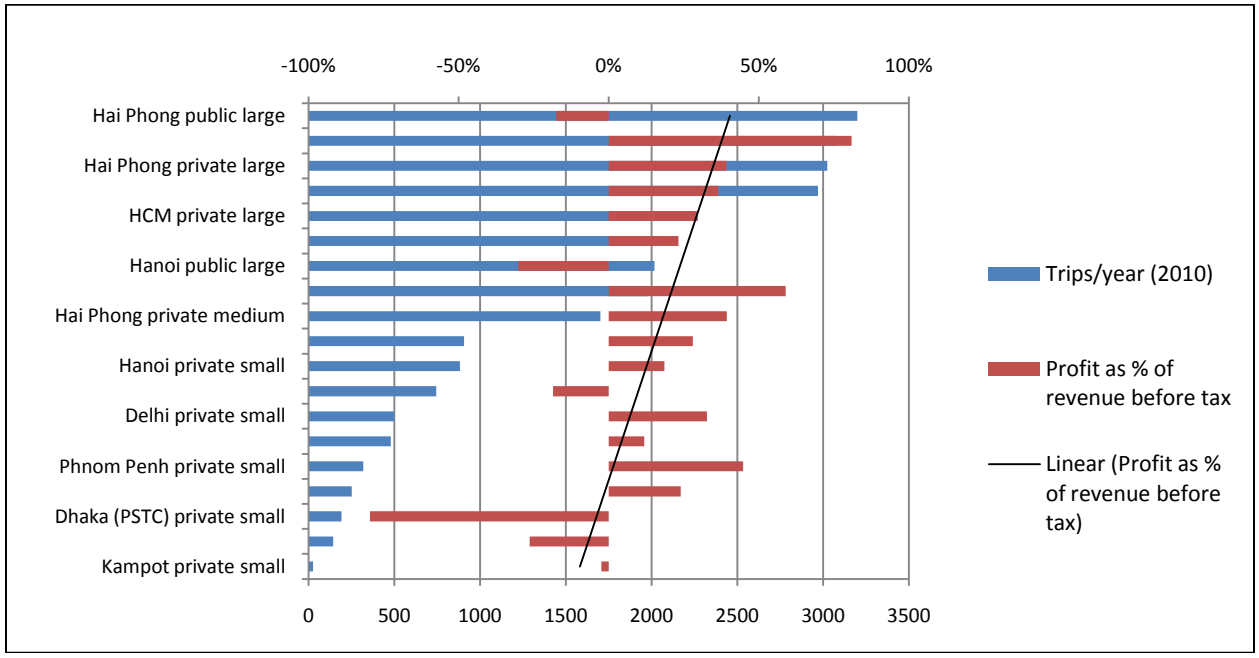
Among the public companies that are not profitable, Faridpur unicipality has an extremely small market (only 13% of the households use mechanical emptying). Hanoi public company concentrates on composting and compost

[33] The bar for Melaka private medium sized company has been removed from the graph, because the extremely low value distorts the graph. This company has a negative return on sales of -451% in 2010.

sales, while Hai Phong public company provides free scheduled desludging paid indirectly from the 15% surcharge on the water bill as mentioned above.

Though a slight correlation can be observed between trips/truck/year and profit as % of revenue, this correlation is stronger for overall trips/year versus % of profit over revenue, even when including the medium sized private company from Melaka (-451% profit). This suggests that large companies are slightly more successful. Please note that in the Figure 28 both Melaka and Faridpur have been eliminated to allow for better visualization of differences among the other companies.

Figure 28 Trips per year (in 2010) and profit as % of revenue



When looking at the trips per truck per year currently carried out by the different business (Figure 29), it becomes clear that medium sized companies (and a selected number of small companies) make more intensive use of their truck capacity.

This is reiterated by the graph in figure 30 on the next page showing the breakeven point together with the number of trucks owned by a company. This shows that the larger companies need to make fewer trips per truck to break even.

Figure 29 The number of trips/truck/year of different companies

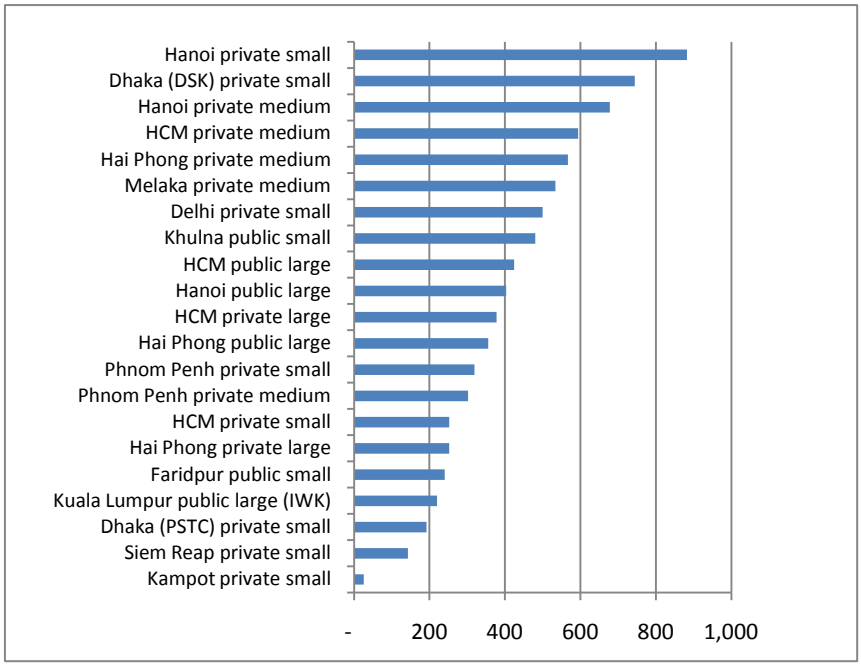
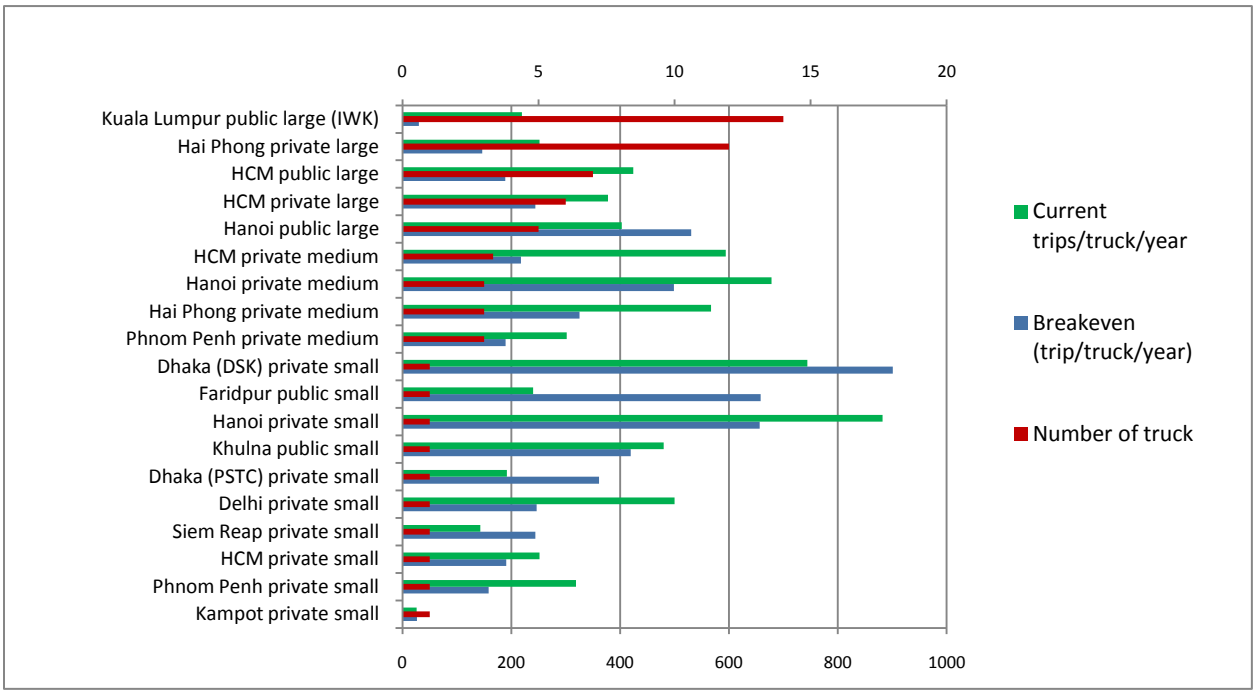


Figure 30 Breakeven point and current trips/truck/year in relation to number of trucks



3.5 TREATMENT AND FECAL SLUDGE END-REUSE

Lack of treatment capacity is a common issue in all cities. Only Malaysia and Hai Phong have fecal sludge treatment plants (FSTP).

Table 19Disposal practices and treatment capacity in the study cities

Country	*Disposal practices and treatment capacity in the study cities*
India	There are sewage treatment plants in all three cities, but far below the capacity required for existing sewage networks[34]. There are no officially designated FS disposal sites, therefore FS is disposed to landfills designed for solid waste or to any open space, land or water. The mixing of solid waste and human waste is common both at neighborhood waste receptacles as well as in sanitary landfills. In Delhi disposal in solid waste dumping sites or open drains is most common, while in Madurai official allow dumping in the channel that leads to the sewage plant. In Jaipur there are no designated sites and sludge is disposed in the environment or illegally let into the STP.

[34] A 2009 study of 498 Class I and 410 Class II towns conducted by Central Pollution Control Board (CPCB) reported that sewage generated was more than 38,000 MLD whilst treatment capacity was only about 12,000 MLD (31% of generation). Nearly 39% of treatment plants do not conform with discharge standards into water bodies. More than 37% of the total human excreta generated in urban India is unsafely disposed off (CPCB, 2009)

Country	*Disposal practices and treatment capacity in the study cities*
Bangladesh	There is one sewage treatment plant in Dhaka, treating 20% of waste water. In Khulna sludge is disposed at the solid waste dumping site of Khulna city corporation, 10km from the city. One FSTP in Faridpur was constructed in 2009, but is not functional.
Cambodia	In Phnom Penh the authorized and mostly used disposal site is Boeung Trabaek pumping station, pumping onwards to Choeung Ek lake (untreated). A dumping fee is to be paid at Boeung Trabaek. Sludge is only dumped in rice field on demand of farmers. In Siem Reap there is a WWTP and all emptiers dump there. A new WWTP is planned. In Kampot there is no authorized site, and discharge takes place in the environment.
Vietnam	All three cities have sewage treatment plants but treatment capacity is insufficient. Hanoi has two pilot WWTP (Truc Bach and Kim Lien) with a capacity to treat 0.9% of the daily waste water production. Another plant treating another 30% is planned to start operations in 2012. In addition to the WWTP, Cau Dzien composting plant uses both solid waste and sludge to produce compost. The plant reports about 50 tons of sludge per day, but only sludge from public toilets is brought there. There is illegal dumping by private companies into the manholes of the sewerage/drainage system. Hai Phong City has a FS treatment facility at the Trang Cat plant where composting, settling and drying occurs. The current amount of sludge received is between 10-25 tons/year. HCMC has 2 sanitary landfills and a WWTP. Four composting plants are planned. There is one private FS composting business.
Malaysia	In Malaysia there are specialized fecal sludge treatment plants (FSTP) using different technologies[35]. The tendency is towards mechanical as opposed to non-mechanical treatment, because there is not much land available anymore. An area of innovation in Malaysia is the use of Geotubes[36] as an alternative to transfer stations. The objective is to reduce the distances travelled by trucks for safe disposal of sludge (currently 50-70 km per trip).

There is an established formal practice of composting and reuse in Vietnam, and also informal re-use arrangements exist in Vietnam, Cambodia and India. Malaysia is presently exploring the different options of re-use. Acceptance for re-use in Bangladesh seems to be reasonable[37], but no experiences are mentioned.

Vietnam clearly has the most evolved practice of re-use integrating it into their treatment model. Practices include:

- co-composting with organic waste and selling (public and private emptiers)
- drying in beds and selling (public and private emptiers)
- selling directly to farmers for fertilizer or fish feeding (private emptiers only)

[35] Centralized sludge treatment facility, Belt press and filter press, Centrifuge decanter

[36] The Geotube is a large bag (14x3 metres) made of porous geo-membrane material. It is installed in a FSTP, allowing for dewatering of sludge and treatment of leachate.

[37] Acceptance of sludge re-use among respondents in the household survey is 56% for Dhaka, 60% for Faridpur and 60% in Khulna.

Hanoi has the Cau Dzien composting plant. FS is composted together with organic waste but the capacity of the plant, high heavy metals and coliform content, uncompetitive prices and lack of proactive marketing means it is not financially self sufficient, and the operation is subsidized by the URENCO. HCMC is considered to be the largest fertilizer market in Vietnam, with 11% organic fertilizers. One company manufacturing and selling fertilizer has built and is successfully operating its own treatment facility for producing fertilizer. The city authorities are therefore exploring other possibilities for privatisation of public services. The Ministry of Health is currently drafting guidelines for the composting of human waste which presumably would attempt to control treatment levels before reuse. Informally sludge is sold directly to farmers for fertilizer and fish feeding. However fish produced on fecal sludge has a low price in the market.

In Cambodia and India[38] direct sales of sludge to farmers also exists. In Delhi some farmers ask for it and pay for the additional transport costs. In Phnom Penh dumping at rice fields is only ad-hoc: when the service is provided in peri-urban areas and farmers come to negotiate with the desludger while operating.

In Malaysia there is commercial and scientific interest to explore various options for re-use e.g. fertilizing and vermi-composting, brick-making and energy production. Some research is being done by universities.

From the above it can be concluded that disposal and treatment is one of the main areas of concern for separating human excreta from human contact in the urban context in all these cities. While treatment capacity is insufficient, also current disposal practices by private companies are an important factor. In Malaysia the economic viability and space for final disposal is a concern. Therefore exploring socially, economically and environmentally acceptable options for both re-use as well as more decentralized safe disposal sites (transfer options) are a necessary area of innovation for all countries. Some interesting examples of composting and re-use are found in Vietnam, while experiences in solid waste management point to the importance of transfer stations.

3.6 MARKET ANALYSIS

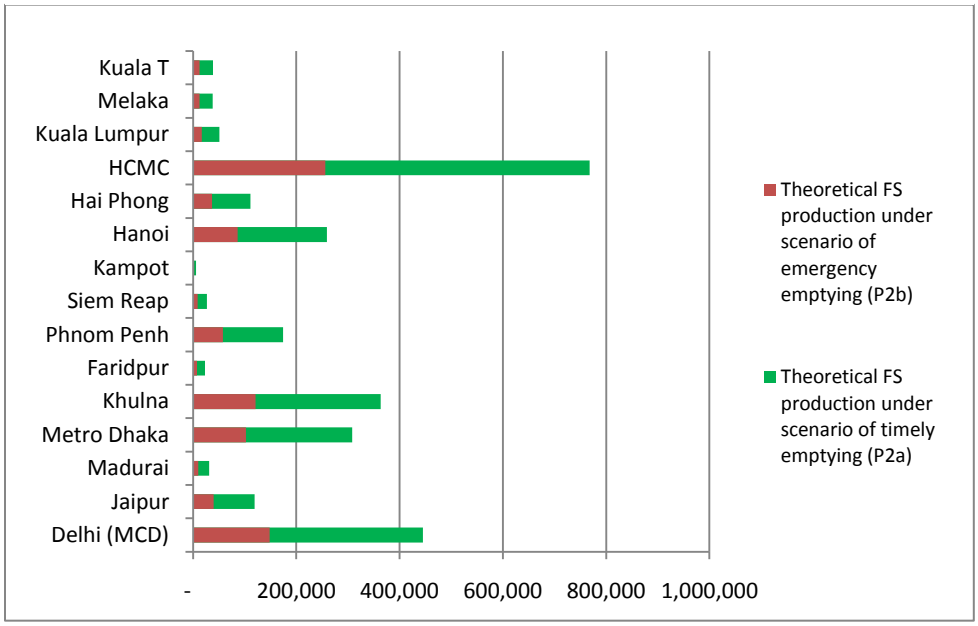
In theory, the potential opportunities for growth in the market of FS emptying and transport lie with the FS facilities that are currently not being emptied, with improved timing of desludging of those facilities that are already making use of emptying services, and with the growth of the population of a city or area. According to the study data, there are over 3.6 million households in these 15 cities that have on-site sanitation facilities that require emptying at some moment in time. Excluding those why say they empty themselves, there are more than 3.5 million who will need to make use of emptying services, which may be considered the potential market for FS emptying and transport. However, according to the household surveys, 1.78 million households say that they have never needed to empty their pits or tanks yet, which leaves 1.74 million households that currently use emptying services, 49% of the potential market.

Taking into account the emptying frequencies, there are approximately 900,000 households that need emptying each year in these 15 cities combined. This group is not equally distributed, however, with much higher percentages of the population requiring emptying in any given year in the smaller Indian cities and Bangladesh, than in Delhi, Cambodia or the Vietnamese cities (Malaysia is somewhere in the middle). (see also the table in section on household surveys). This reflects the different distribution of emptying frequencies in these cities.

[38] The India report also mentions a pilot experience from Tamil Nadu where a Vertical Flow Constructed Wetland has been constructed for the treatment of septage. The intention is to use the vegetation for further composting.

About half the population requires emptying within a period of three years, with the other half of the households using services once every 4-10 years. Also, data suggest that within the group of households that empty within 3 years, almost 35% empties every year or several times a year.

Figure 31 FS production under the scenario of emergency and timely emptying (in m3/year)



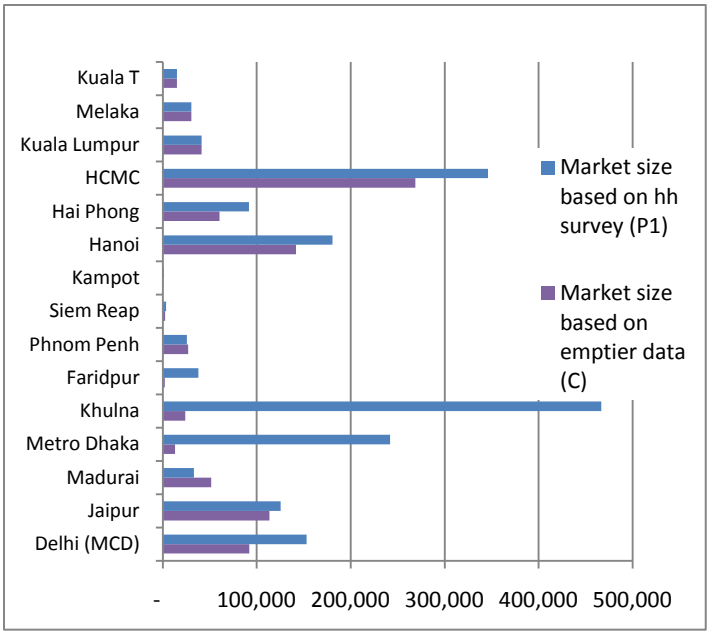
Given that the size of the tanks of these households is quite large, this would suggest that these facilities are not working properly or that these are not really septic tanks. These households are predominantly found in Jaipur, Madurai and Dhaka.

Apart from the number of household that require services at a certain moment in time as well as in any given year, the market can be characterized by the volume of FS that needs to be emptied. Figure 31 shows the estimated amounts of FS that are produced each year, and thus need to be emptied each year[39]. This estimation is based on the number of households theoretically needing services (3.6 million for all cities combined). As explained in the methodology sections, the outcome of the estimations depends very much on the assumptions used regarding the FS accumulation rate in tanks and pits. In addition to these assumptions, different scenarios can be applied regarding the saturation of the facility at the time of emptying. In this report, two scenarios are used: a scenario where timely emptying is applied which results in maximum FS production in the city, and a scenario of emergency emptying which results in a minimal FS production with a higher sludge content. The timely emptying scenario is based on the premise of a two third free liquid volume in the collection facilities in order to ensure optimal anaerobic decomposition, resulting in a FS volume that contains two-thirds liquid. Under the emergency emptying scenario the facility is only emptied when it is saturated with sludge and the effluent contains insufficiently treated sewerage. The resulting FS volume contains primarily sludge. In Figure 32, the volumes of FS for the two scenarios can be seen for each of the cities. The actual value of FS is likely to be somewhere in between these two scenarios as different households apply different approaches to the emptying of their sanitation facilities.

[39] See the section xxx in the methodology and annex… for background on these estimates.

Apart from the theoretical market size based on the FS production rates, the market can also be estimated based on data from the household and business surveys regarding emptying frequencies and number of trips, together with the corresponding tank volumes and truck capacities. As can be seen in the next graph, the two calculations of the volume of FS emptied in a given year are more or less in the same range for most cities, except the cities in Bangladesh. There are two possible explanations of this large difference in Bangladesh, both related to the fact that Bangladesh has a large incidence of manual emptying:

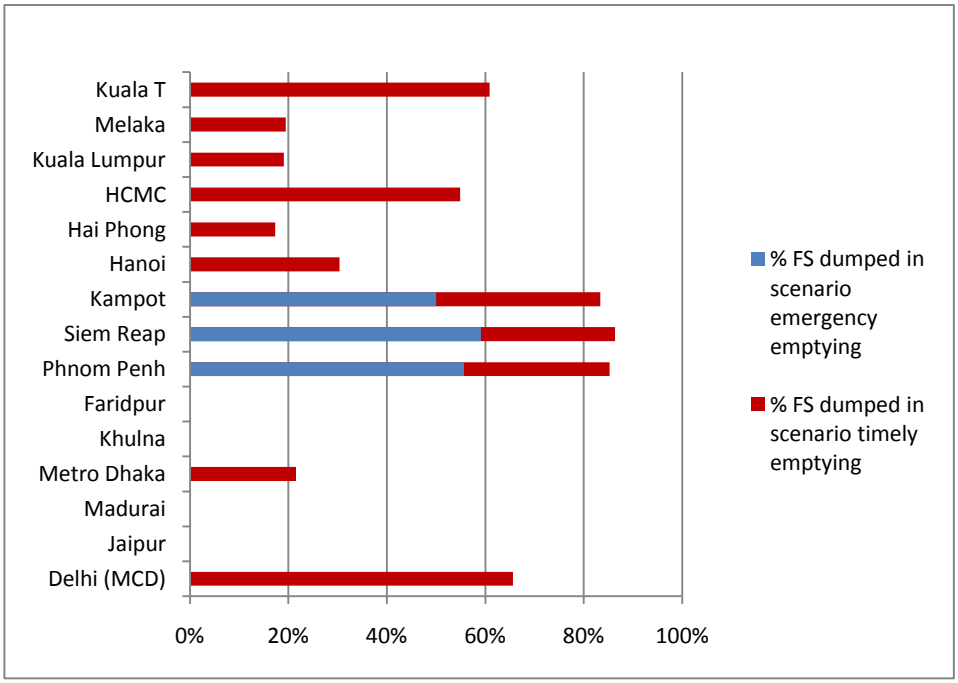
Figure 32 Volume FS emptied according to households and businesses in m3 / year



1. No data are available from manual emptiers about the volume they empty. While an estimate was made on the basis of data from mechanical emptiers, this was based on the percentage of households making use of manual emptying according to the household survey (between 60% and 96% of all households in the survey area). Given that the survey was based on purposive sampling, it is likely that the percentage of households using mechanical emptying services was over represented and that the volume emptied manually is in fact much greater.

Figure 33 Percentage of the produced volume of FS not collected

2. Households might have responded that they use mechanical emptying to give a more socially acceptable answer. This would also mean that the percentage using manual emptiers is even higher than found in the household survey, thus meaning that the total volume collected by the emptiers (mechanical and manual) is larger and more in line with the estimation.



In figure 33 on the next page the estimated theoretical FS production is compared to what is currently collected by emptying and transport services (according to the household survey). The graph shows that especially the Cambodian cities face a real challenge regarding household behavior: under both scenarios for the calculation of the theoretical FS production, there is a considerable percentage of the total FS production that is not being emptied by service providers. For the other cities, it depends on what is considered an acceptable saturation level of the septic tank.

The graph also shows that in most cities the potential growth of the market will depend on the capacity of the government to enforce timely emptying / planned desludging. Said differently, there seems to be no unmet demand in the market related to emergency emptying except for the Cambodian cities. Moreover, in Jaipur and Madurai as well as Faridpur and Khulna, there is no unmet demand even under the scenario of timely emptying. While this could suggest that sanitary conditions in these cities are excellent, it might be more related to the high incidence of pits and tanks that are emptied several times a year or annually, despite their relatively large size (the average size of these tanks is considerably higher than the average pit size in Southeast Asia). Alternatively, the explanation could lie in a very high variation of pit sizes, and the distribution of these different pit sizes over the different frequency classes for emptying, which has a significant effect on the calculation of the emptied volume. It seems important to do a doer/non-doer analysis to understand better why some households empty their pits much more frequently than others.

Under the scenario of timely emptying[40] either by enforcement or scheduled desludging, the total FS emptying market in these cities would potentially increase from 1,79 million cubic metres per year to 2,76 million cubic metres per year, equivalent to approximately 40 million USD.

3.7 BUSINESSES CASE ASSESSMENT

The business case assessment aims to look the different businesses cases put forward by the countries to make fecal sludge extraction and transport in the respective cities more financially, socially and environmental sustainable. As was discussed in previous sections, this involves demand, regulation, business models, technology, treatment modalities and capacities, and so on. So far only three countries have included a business case in their report:

I. Malaysia: Reducing operating costs of the Melaka private medium company by installing Geotubes

II. Bangladesh: Creating proof of concept of mechanical emptying in Bangladesh through a combination of improved equipment, regulation and awareness raising

III. Vietnam: Improvement of the Hai Phong model with publicly managed scheduled desludging and participation of private companies (2 yearly)

In the following some characteristics of each business case will be presented and after that some suggestions will be given.

[40] Please note that the definition of timely emptying used here is the two thirds of free liquid volume. Therefore the Malaysian cities also show possibility of market increase. However, as their research has found, a 56% free liquid volume also gives acceptable effluent quality, so it's unlikely that a scenario of 66% of free liquid volume is needed in all cases to ensure health and safety.

3.7.1 MALAYSIA: REDUCING OPERATING COSTS OF THE MELAKA PRIVATE MEDIUM SIZED COMPANY BY INSTALLING GEOTUBES

The private medium sized company in Melaka currently has a negative NPV and a very low IRR and ROE, as well as a negative return on sales of -451%. One of the main factors is the large distance to be covered to the disposal site (30-50km on average). This increases operating costs and reduces the number of clients the company can service per day and increases the operating costs per client.

The main elements of the proposed business case are to install Geotubes within existing sewage treatment sites that will be responsible for treatment of the leachate that is generated from the Geotube using available treatment plant facilities. As a result, the maximum distance of travel to deposit the FS will be no more than 15km. In addition the model foresees the renewal of the three trucks of the company and new office equipment, with 80% of all fixed assets financed by banks. The key assumptions of the business case are a tariff of 70 USD together with the continuation of scheduled desludging which ensures a demand of at least 3 trips per day per truck.

Table 20 Comparison of current situation and proposed model of medium Melaka company

	Current situation	Proposed model
NPV	- 5,562	75,082
IRR after tax	7%	18%
decrease revenue 5%	*0%*	*10%*
increase operating costs 5%	*2%*	*12%*
increase fuel 50%	*4%*	*15%*
Average 5 year ROE	3%	18%

The proposed business case will make mechanical emptying by the medium private sector profitable, from the first year. The table shows that the resulting financial ratios are significantly improved compared to the current situation. The NPV has become positive and can be considered to be quite high, while the IRR has more than doubles and the ROE has become 6 times as high. The sensitivity of the IRR to changes in revenue, operating costs or fuel prices has also become less, and IRR levels continue to be higher than the 8% bank interest rate used in the model.

The necessary investments by the company are very similar to the investments that the company made under the existing scenario. The big innovation is of course the installation and the operation of the Geotubes. However, from the text it is not clear how much investment this would require nor who would assume those. This is also the main comment on this otherwise very interesting business case.

3.7.2 BANGLADESH: CREATING PROOF OF CONCEPT OF MECHANICAL EMPTYING IN BANGLADESH THROUGH A COMBINATION OF IMPROVED EQUIPMENT, REGULATION AND AWARENESS RAISING

In spite of the health risks, stigma and drudgery related to it, manual emptying is the norm in Bangladesh and it has proven very difficult for mechanical emptiers to establish themselves in the market. Only 30%, 2% and 13% of households use mechanical emptying in Dhaka, Khulna and Faridpur respectively. One factor is the price difference (3x as expensive in Khulna and Faridpur) and another factor is the knowledge of households about mechanical emptying services, as well as perceptions about the service (availability, bureaucratic hassle, cleanliness e.g.). Companies in Bangladesh are all small, initiated by NGOs and three out of four are operating at a loss.

The main elements of the proposed business case are to Increase in the number of trucks to 2 and the number of trips from 16-62 trips per month to 176 trips per month, aiming at a market share of about 0.37% in Dhaka, 0.24% in Khulna and 2.34% in Faridpur[41]. The equipment would also be changed to a third generation vacutug with an intermediate tank size of $1m^3$ (previous sizes were either $0.6m^3$ for the first generation and or $2m^3$ for the second generation) mounted on a pickup, making it both faster that the first generation vacutug and easier to maneuver in small lanes than the second generation. The price would be maintained at a low level similar to that of manual emptying. The model also foresees increased efficiency, with costs increasing 2.2 times with respect to the current situation, against a 2.8 times increase in revenue.

The key assumption of the business case is that there will be a greater demand (nearly 3 times as much) as a result of enforcement of regulatory measures against disposal of raw sewage in storm drains, leading to proper operation of pits and septic tanks. At the same time, enforcement of regulation of proper dumping of emptied FS is expected to decrease the domination of the manual emptiers that currently have the liberty to dispose the extracted FS as they please.

Table 21 Comparison of Bangladesh proposal

NPV	17,687
IRR after tax	36%
increase revenue 10%	*69%*
decrease revenue 10%	*28%*
increase operating costs 10%	*33%*
decrease operating costs 10%	*60%*
Average 5 year ROE	8%

The benefits of the proposed model are shown in the table. The NPV is considerable for such a small company, and the IRR is very high. The model also foresees a positive return on sales of 9% in the first year (against a current loss of 3% in the case of the second generation vacutug), increasing to 21% after five years. The sensitivity of the business model to changes in revenue or operating costs to the IRR is quite low, showing low vulnerability to market changes.

While the activity is justified and necessary from a social and environmental perspective, the main comment is that the expected increase in demand cannot be estimated reliably. This will depend largely on the assumptions regarding enforcement of regulation, which is beyond the influence of the business. In order to improve the proposal, more attention could be given to the potential of marketing and social marketing, as well as to the conditions needed for safe disposal. Also, a doer/non-doer analysis of household emptying behavior or any similar formative research might be needed to better understand the factors that influence consumers.

Furthermore, the management of the companies may merit more attention. One of the issues emerging from the report is the corruption among emptier staff. As the proposal includes an increase in operating efficiency, it may be important to have a close look at the checks and balances as well as incentives within the companies. Clear boundaries between the company and NGO operation is a requisite[42].

[41] These percentages are extremely low, but the scenario might not be that bleak. With 176 trips per month over 12 months, the proposed business would absorb 0.6%, 0.5% and 8.3% of the total number of households in the surveyed areas in Dhaka and in the whole of Khulna and Faridpur.

[42] For reference see also the social marketing work done by WaterSHED Asia in Cambodia, called “hands-off approach”. The underlying idea is that the businesses who work well with NGOs are not necessarily the same ones that have what it takes to be competitive in the market.

3.7.3 VIETNAM IMPROVEMENT OF HAI PHONG MODEL

Under the current scenario, the main public enterprise HP SADCO is still running a loss after 5 years (with a negative NPV $17,958), requiring cross-subsidy from other branches of the company. The capacity and infrastructure of HP SADCO is not fully utilized and moreover only 4-6% of the current surcharge (of 15%) is used for FSM, with the other part used for waste water. Private companies are also not using their full capacity, and in addition do not deposit the sludge in a proper location. The team estimates that currently 87% of sludge emptied in the city ends up in the environment through illegal disposal by private companies. It is furthermore estimated that the city produces three times as much sludge in reality, which is currently unsafely discharged by households and other customers themselves.

The main elements of the proposed business case are scheduled desludging every 2 years with a major role in the management of FS emptying for Hai Phong SADCO, increased marketing activities for regular septic tank and pit desludging, and increased surcharges in the water bill (from 15% today to 20% in 2012 and 25% in 2015). The scheduled desludging will allow the truck productivity to be improved by maximising the number of trips per day per truck. The model also foresees the creation of a legal framework and regulation for FSM activities, as well as enforcement of this by the city. Improved treatment technology at compost plants is expected to result in additional revenue, while a study on integrated waste management is recommended to look at co-treatment of FS and organic fractions of solid waste.

Table 22 Comparison of Vietnam proposal

	Private large		Private medium	
	Current	Proposed	Current	Proposed
NPV	46,454	653,496	17,912	37,752
IRR after tax	72%	n/a	73%	163%
Average 5 year ROE	16%	36%	13%	16%

The assumption in this business case is that the number of trips per year of all involved companies will triple and in the case of the large private company quadruple.

The proposed changes are expected to improve the performance of the private large and medium companies active in Hai Phong, with increases in all financial ratios. However, despite the report mentioning that the model results in profits for all companies involved, including SADCO, the data shows the NPV for SADCO further decreasing from -$17,958 in the current situation to -$755,250 with the proposed changes. This will need to be verified, and other changes recommended if found to be correct.

The benefits of the proposed business case are first of all to increase the volume of sludge that is disposed safely and/or treated. Costs of the proposed business case are about 5 million USD in investment in infrastructure, research, set-up of regulation and awareness raising over 3 years. Risks are not discussed.

On another level, the proposal aims to achieve a degree of “proof of concept” of the idea of integrated waste management, to be used for the development of sustainable waste management in other cities in Vietnam and in the region.

A serious concern with regard to this model, is that willingness to pay could become a problem. With the current surcharge of 15% and an emptying frequency of 2 years, households pay 18.43 USD per emptying on average. If the surcharge is 25%, the payment over 2 years will be 30.72 USD. This is significantly more than the current fee for demand responsive service in Hai Phong (21.7USD) and also more than is being paid in Hanoi or HCMC.

In addition to this model, the Vietnam team did some interesting calculations on scheduled desludging and emptier incentives in Hanoi and HCMC. It may be worthwhile to further analyse those different scenarios.

4 REFLECTIONS AND RECOMMENDATIONS

Fecal sludge management in general, and FS emptying and transport services in particular, are a significant part of the solution towards hygienic separation of human excreta from human contact. By far the largest capacity for emptying in India, Bangladesh, Vietnam and Cambodia, lies with the small and medium private sector. Though larger companies seem to be slightly more successful as they need to make less trips per truck to breakeven, it is the group of the small and medium sized businesses that has household emptying as their predominant source of revenue. Yet their potential cannot be realized if FS emptying and transport services remain to stand on their own.

The majority of the existing FS emptying and transport businesses seem to be responding adequately to the demand for such services, the businesses appear to be profitable with a few exceptions and customer satisfaction is high. Overall the market works. However, the problem is not in the market, but in the externalities. Current household FS disposal practices tend to operate predominantly under the emergency emptying scenario, while private FS emptiers reduce operating costs by illegal dumping. Therefore, although the demand for services appears to be fully met in terms of quantity, the unregulated businesses, ad-hoc contracting and strong competition on price is simply not resulting in quality sanitation.

One of the crucial issues, looking at the overall FSM, is the need to finance not only the emptying and transport services but also the treatment. Except for one experience in HCMC, treatment and/or composting has not yet proven to operate at full cost-recovery, let alone be profitable. At the moment, treatment capacity is grossly insufficient. In many countries there are only STP or WWTP, which are inadequate to receive FS. In South Asia, FS tends to end up in the solid waste chain. Large distances to dumping sites, dumping fees and/or harassment further contribute to the lack of incentives for private emptying businesses to bring the sludge to a proper location. Composting seems to be a promising form of re-use for practically all countries, but it requires more research to ensure quality of end products and also needs certain management improvements.

Also, FSM is falling between the cracks of planning, investment and legislation. It is often unclear whether it belongs to solid waste or sewerage, and ends up being low priority for the local authorities in charge. Only in Malaysia FSM is a federal responsibility. Interest of key influential stakeholders is low, whilst the private sector and consumers are not sufficiently organized to have any significant influence. Public utilities are influential, but FSM is not their priority.

In this context, simply “more enforcement” is not going to work. Nevertheless enforcement is necessary, especially of existing building codes. Also, change is not going to come from the businesses alone. The vast majority of small “survival type” businesses are not going to engage nor are the larger public businesses for which household emptying is a minor share of their income. Further, the FS emptying businesses analysed in the study, are surprisingly sensitive to changes in the market and therefore unlikely to take risks. Innovation therefore has to come from a combined effort of all stakeholders.

Among the different country reports various ideas are given for improving business models and fecal sludge management models, most importantly:

- Incentive payments to businesses for dumping at the disposal sites/ treatment
- Scheduled desludging with a surcharge in the bill of one of the other key services, which will allow businesses to operate their trucks more efficiently and dump safely.
- Reduction of operating costs by increasing/ installing FS transfer stations (in Malaysia with Geotube).

An incentive payment to businesses for dumping at the disposal sites/ treatment plants is interesting, but it is unclear where the payment would come from and who would ultimately generate the funds. Installing transfer stations has high potential in any of the other countries, in addition to Malaysia, but it will need further research on how to make this cost effective and how to adjust it to each country’s context. Furthermore this needs to be done in combination with increasing demand for services.

Scheduled desludging with a surcharge in the bill of one of the other key services seems to be the way to go. Yet, this will require significant political will and commitment. Moreover the data on Malaysia and Hai Phong are showing that the cumulative payment in installments in these cities ends up being 50% higher than the one time cost of emptying under a demand driven approach. A higher price for emptying is likely to undermine this approach, in particular in the South Asian countries, and will require skilled behavior change communication.

Furthermore, following the suggested analogy with solid waste management, it might be worthwhile to think further and look for models that could improve both quality of service and accountability. For example, what is the scope for association or micro-franchising models of fecal sludge emptying services? What is the scope for longer term service contracts packaging both construction/repairs and maintenance services? We have not seen such ideas so far.

The first step, however, is to increase awareness and political will with decision makers.

5 REFERENCES

Asian Development Bank (2009) "Asian Sanitation Data Book 2008, achieving sanitation for all" Asian Development Bank, Citynet, UN-Habitat, Veolia Environment, Mandaluyong City, Philippines:

AECOM International Development, Inc. and the Department of Water and Sanitation in Developing Countries (Sandec) at the Swiss Federal Institute of Aquatic Science and Technology (Eawag) (2010) "A rapid assessment of septage management in Asia, policies and practices in India, Indonesia, Malaysia, the Philippines, Sri Lanka, Thailand and Vietnam", ECO-Asia Regional Development Mission for Asia (RDMA) USAID, USA

Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning (2011), "Population & Housing census 2011, Preliminary results", , accessed at the Bangladesh bureau of statistics. http://www.bbs.gov.bd , 23p

Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning (2010) "Preliminary report on household income & expenditure survey (HIES) 2010", accessed at. http://www.bbs.gov.bd

Bill & Melinda Gates Foundation (2011) "SCOPE OF WORK: Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Asia", USA (internal document)

ERE Consulting Group, Indah Water Korsortium (IWK), (2011) "Landscape analysis and business model assessment in Fecal Sludge Management: Extraction and Transportation Models in Malaysia, interim and final report, Kuala Lumpur, Malaysia

General Statistics Office of Vietnam (2009) "Vietnam population and housing census 2009, part II" accessed at http://www.gso.gov.vn/

GRET, "Landscape analysis and business model assessment in Fecal Sludge Management: Extraction and Transportation Models in Asia", Cambodia (interim and final reports)

Indah Water Korsortium website http://www.iwk.com.my/

Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering (2011) "Landscape analysis and business model assessment in Fecal Sludge Management: Extraction and Transportation Models in Africa and Asia, Interim and final report Vietnam, Hanoi, Vietnam

JMP (2010) Country reports accessed at http://www.wssinfo.org/documents-links/ documents /?tx_displaycontroller%5Bcategory%5D=&tx_displaycontroller%5Byear%5D=&tx_displaycontroller%5Bregion%5D=UNICEF:8&tx_displaycontroller%5Bsearch_word%5D=&tx_displaycontroller%5Btype%5D=country_files

Khulna City Corporation official website http://www.khulnacity.org

www.indiastat.com

http://indiasanitationportal.org/

Ministry of Urban Development, Government of India (2008), "National Urban Sanitation Policy "(NSUP), Delhi, India

National Committee for Sub-National Democratic Development (NCDD) (2009) "Siem Riep provincial databook " Siem Reap, Cambodia

National Committee for Sub-National Democratic Development (NCDD) (2009) "Kampot provincial databook", Kampot, Cambodia

National Sanitation Task Team, Department: Water Affairs and Forestry, Health, Education, Provincial and Local Government, Housing, Environmental Affairs and Tourism, Public Works, Treasury South Africa (2002) "Sanitation Technology Options Handbook of South Africa", South Africa

Rahman, M (2009) "Sanitation Sector Status and Gap Analysis: Bangladesh September 2009", National Sanitation Taskforce, Bangladesh, Global Sanitation Fund, Water Supply & Sanitation Collaborative Council

Right Angle (2011) "Landscape analysis and business model assessment in Fecal Sludge Management: Extraction and Transportation Models in Asia", India (interim and final reports)

Still. D.A. "After the pit latrine is full-What then? Effective options for pit latrine management", Partners in Development South Africa, accessed at http://www.susana.org/docs_ccbk/susana_download/2-891-207-paper2.pdf ,

Tilley, E. et al, "Compendium of Sanitation Systems and Technologies", 2008, EAWAG, WSSCC, Switzerland 158p

Tsitsikalis, A. et al (2011) "Landscape analysis and business model assessment in Fecal Sludge Management: Extraction and Transportation Models in Asia, Preliminary report", GRET, France

WaterAid America, (2011) "Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Bangladesh", USA (interim and final reports)

WEDC, "Unit 5 Septic tanks and aquaprivies in Low cost sanitation",

WHO, (2011) "10 facts on sanitation" accessed at http://www.who.int/features/factfiles/sanitation/en/index.html

6 ANNEXES

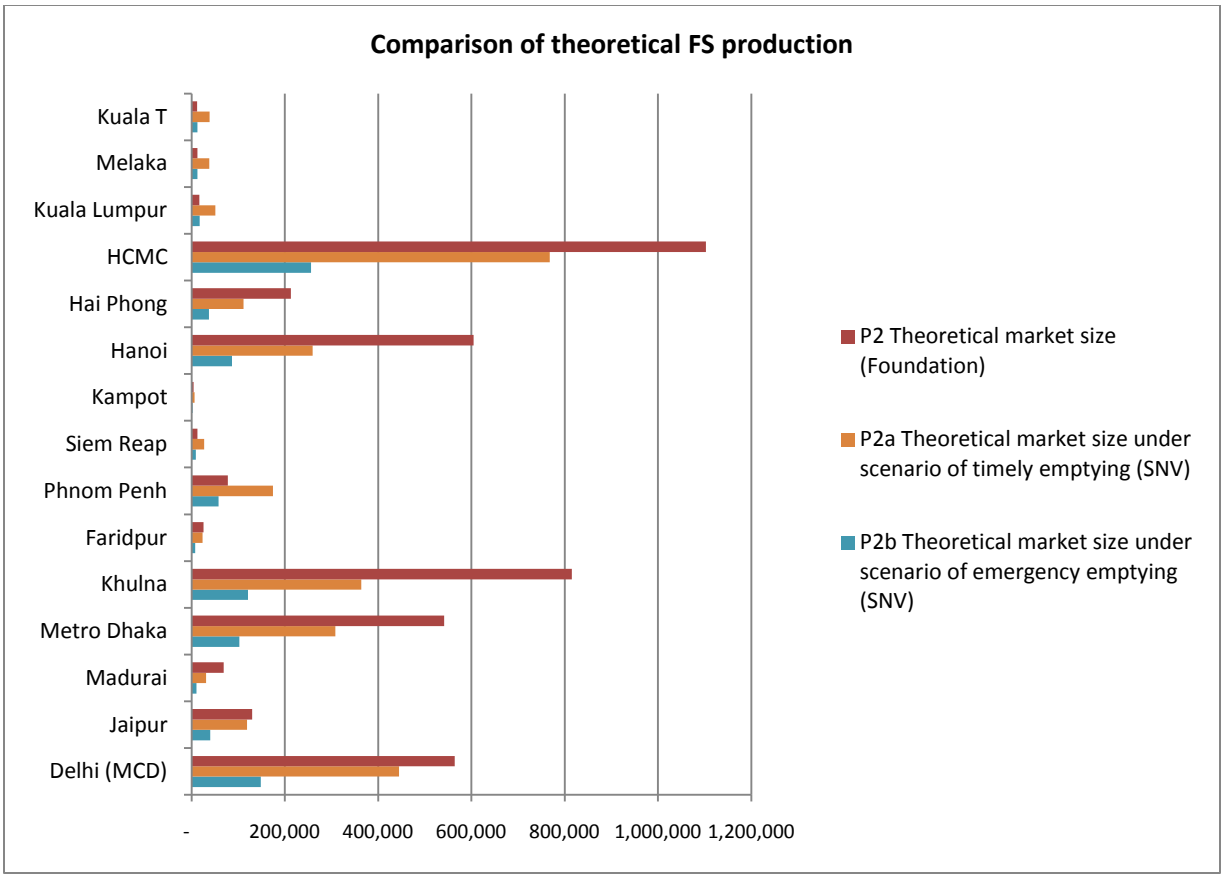
6.1 DIFFERENCES IN THE FS CALCULATIONS

As mentioned in the methodology, there are different approaches for calculating the market size, based on i) theoretical FS production (P2), ii) households survey data regarding emptying frequency and tank size (P1), and iii) data provided by the emptying businesses regarding number of trips per year and truck capacity (C).

Potential market size based on theoretical FS production (P2). For the first approach the assumptions made for the FS accumulation rate, as well as for the recommended free liquid tank volume are of major influence. For the FS accumulation rate the international recommended rates are between 0.2 and 0.85m^3 per capita per year. For the free liquid volume, a recommended volume of two thirds is given by many sources to ensure proper anaerobic decomposition. Emptying is thus necessary when the semi-solid fraction exceeds one-third of the tank storage capacity (this is referred to in this report as timely emptying). This percentage is not beyond doubt, however, and Malaysia for example found that effluent quality is still acceptable with a free liquid volume of 56%. In practice most households will only empty their tanks when they are smelly and raw sewerage flows out, i.e. when the free liquid volume comes close to 0% (this is referred to in this report as emergency emptying).

The FS production rate is essentially what is emptied from the tanks, both liquid and semi-solid fractions. To calculate the volume under the scenario of timely emptying would require multiplying the accumulation rate by a factor 3. In the emergency emptying scenario the FS production rate approximates the FS accumulation rate. The "real" rate is somewhere in between these two values and depends on the approach of different households to emptying their sanitation facilities.

Given the information above, it appears that the calculations of the theoretical FS production as included in most country reports based on the Foundation formula, are giving an overestimation of the FS production in the cities. The following graph shows the difference between the calculation of the theoretical FS production using the formula proposed by the Foundation, and using the calculation as mentioned above.

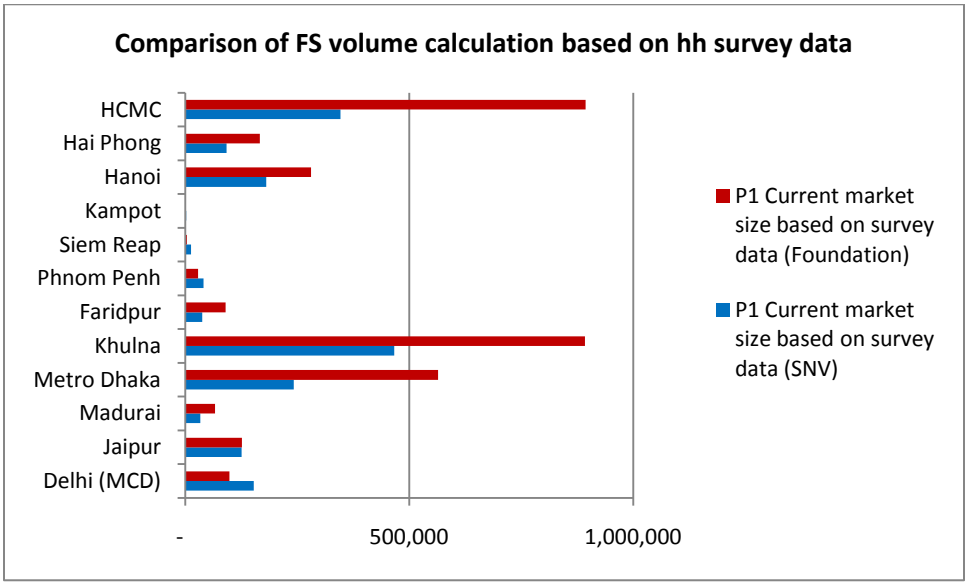


In most cases the calculation based on the Foundation formula is higher. Only in the case of the Malaysian team are the calculations lower because their P2 calculation is based on their actual records of emptied FS volume (as mentioned lower than 66% free liquid volume) instead of the recommended formula. The P2 calculation for Cambodia is very low because they used a sludge accumulation rate calculated from the actual emptying frequencies, which involve probably more emergency emptying than timely emptying. The calculations included in the India and Bangladesh reports are considered far too high due to the very high assumptions they made which do not seem to be based on any measured values. Vietnam's rates seem to be based on research, but are still quite high.

Current market size based on household data (P1). The proposed calculation for the current market size based on the responses given by the household survey, is in itself a sound calculation. However, the use of the same average pit size for all frequency classes distorts the total market volume, mostly resulting in an overestimation. This was simulated by using the actual pit sizes corresponding to each frequency class as well as the total average pit size for all frequency classes. In addition, a number of other minor calculation errors were made in the reports (mostly for Bangladesh). The Cambodia team did provide the pit size for different frequency classes, but applied the average pit size for the calculation of the current market size according to the Foundation's instructions. However, in this report the calculations according to the actual pit sizes are used.

The precise calculation cannot be done without the pit and tank volumes for each frequency class, and as this is likely to be in the household data. It is recommended to request all countries for those data to ensure that the calculations are more accurate. However, on the basis of the existing data a better approximation of the current market size can be made by correcting the average tank size for the average emptying frequency. Please note this

is still an approximation. The difference between the two calculations is given in the graph below. Malaysia has not been included in this comparison, because the frequency classes provided by Malaysia do not add up to a 100%. The Delhi calculation by SNV is higher than the calculation by the Foundation, which reflects a downward distortion of the Foundations calculation, due to the fact that in Delhi there are no households in the higher frequency classes (all pits are emptied with 3 years or more interval and all tanks with 5 years or more interval). This also gives a higher distortion (downward) for the SNV calculation.

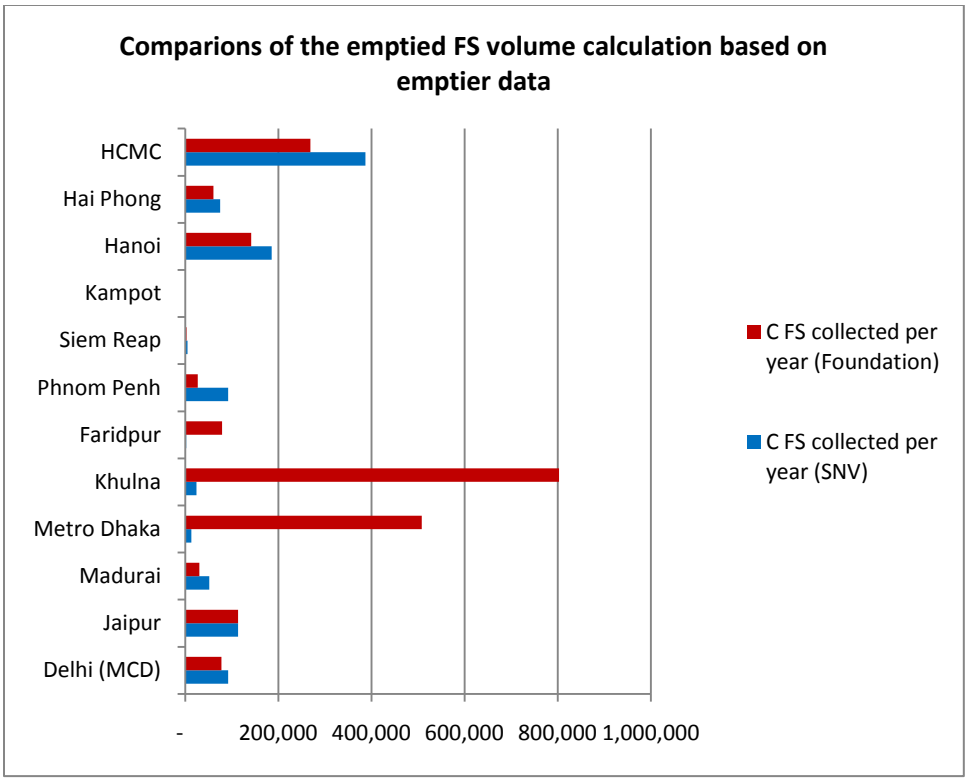


The approximation uses the following formula (similar for pits, tanks and so on):

Average pit size/Average emptying interval in years x number of pits

The average interval has been calculated using the sum of the percentage of pits in each frequency class multiplied by the emptying interval of that class.

Current market size based on the business survey (C). The calculation of market size based on data provided by the emptying businesses uses a calculation that is basically the same as that provided by the Foundation. Only for the calculation of the volume of FS emptied manually, the average volume of pits emptied by mechanical emptiers was used instead of the average pit volume. It was assumed that the volume emptied by manual emptiers per household is similar to that emptied by mechanical emptiers. The calculation for the mechanical emptying is the same. For the Vietnamese cities, the estimate by the team is probably more accurate, because they have based it on the specific truck sizes (not the average). For that reason the value from the Vietnamese team is used in the report. The overestimation for Bangladeshi cities also results from an overestimation of the number of users per facility.


Comparions of the emptied FS volume calculation based on emptier data
HCMC
Hai Phong
Hanoi
Kampot
Siem Reap
Phnom Penh
Faridpur
Khulna
Metro Dhaka
Madurai
Jaipur
Delhi (MCD)
-
200,000
400,000
600,000
800,000
1,000,000
C FS collected per year (Foundation)
C FS collected per year (SNV)

7 GLOSSARY

Acceptance rate	Term used by the Malaysian country team to indicate the percentage of the population using FS emptying services in a given year
Biosolids	the byproduct of the treatment of domestic wastewater in a domestic wastewater treatment plant. Biosolids consist primarily of dead microbes and other organic matter and can be used as organic fertilizer or soil amendments.
Coverage	does not indicate functionality or use
Desludging	the process of cleaning or removing the accumulated septage from a septic tank or wastewater treatment facility.
Desludging/ emptying	manual or mechanical emptying of pits, tanks or vaults at customer's premises
Digestion	a microbiological process that converts chemically complex organic sludge to methane, carbon dioxide, and inoffensive humus-like material.
Domestic Sewage	wastewater composed of untreated human waste coming from residential and commercial sources. Domestic sewage does not include industrial and/or hazardous wastes.
Drainage	designed for surface or storm water, not sewerage
Effluent	a general term for any wastewater, partially or completely treated, or in its natural state, flowing out of a drainage canal, septic tank, building, manufacturing plant, industrial plant, or treatment plant.
Faecal Sludge Management	also known as septage management, FSM concerns the various technologies and mechanisms that can be used to treat and dispose of sludge – the general term for solid matter with highly variable water content produced by septic tanks, latrines, and wastewater treatment plants.
Improved Sanitation	Hygienic separation of human excreta from human contact, can be by a connection to a public sewer or septic system, or access to a pour-flush latrine, a simple pit latrine or a ventilated improved pit latrine, according to the JMP definition
Improved Water Supply	access to a household connection, public standpipe, borehole, protected dug well, protected spring, or rainwater collection, according to the definition.
Manual emptying	By hand or using hand powered equipment
Mechanical emptying	Using mechanically powered equipment, including vacutugs, vacuum tankers
Onsite Sanitation System	infrastructure that aims to contain human excreta at the building; comprises of septic tanks and improved latrines. Does not exclude connection to a piped network.

Pits	may be infiltration/ soakaway or lined, but not deigned to treat (unlike septic tank)
Soakaway	a hole in the ground that receives the effluent from a septic tank and allows the effluent to seep through the pit bottom and sides; may be lined with bricks or filled with gravel.
Septage	the combination of scum, sludge, and liquid that accumulates in septic tanks.
Septic Tank	a watertight, multi-chambered receptacle that receives sewage from houses or other buildings and is designed to separate and store the solids and partially digest the organic matter in the sewage.
Service Provider	a public or private entity, operator or water utility that is engaged in the collection, desludging, handling, transporting, treating, and disposing of sludge and septage from septic tanks, cesspools, Imhoff tanks, portalets, sewage treatment plants.
Sewage	Mix of liquids and solids produced by humans, which typically consists of washing water, feces, urine, laundry wastes, and other material that flows down drains and toilets from households and other buildings.
Sewer	a pipe or conduit for carrying sewage and wastewater
Sewerage	a system of sewers that conveys wastewater to a treatment plant or disposal point. It includes all infrastructure for collecting, transporting, and pumping sewage.
Sewerage/ conventional sewerage	piped, below ground conventional sewerage, may or may not go to treatment
Sludge	precipitated solid matter with a highly mineralized content produced by domestic wastewater treatment processes.
Stabilization	the process of treating septage or sludge to reduce pathogen densities and vector attraction to produce an organic material that may be applied to the land as a soils conditioner
Toilet	User interface, may be Improved or unimproved, HH or communal, public or privately owned
Treatment	waste water or sewage treatment designed to reduce pathogen content, by natural, chemical or biological means
Water Supply	Any system or facility that provides access to water for human personal use.