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WORKING PAPER

LANDSCAPE ANALYSIS &
BUSINESS MODEL ASSESSMENT

Fecal Sludge Management in Cambodia

OVERVIEW AND KEY FINDINGS

March 2012

Foreword

This case study was conducted as part of a global study entitled “Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models” which has been funded by the Bill and Melinda Gates Foundation in 5 Asians Countries (Cambodia, Vietnam, India, Malaysia, Bangladesh) and 5 Africans countries (Burkina Faso, Kenya, Ethiopia, Senegal, Nigeria). The data were collected between May and September 2011. This document is a synthesis of the main report provide to the Bill and Melinda Gates Foundation in November 2010. For specific cities study cases results, you can refer to the volume dedicated to each city.

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Acknowledgments

The authors are grateful to the following people, for their support and help and comments that they made during all process of study implementation: Ms. Sangeeta Chowdhry (Bill & Melinda Gates Foundation), Mr. Doulaye Kone (Bill & Melinda Gates Foundation) and Ms. Antoinette Kome (SNV Asia).

The authors also would like to thank the following for the interviews they accepted and for the information that they gave us during the field surveys: all national and local stakeholders involved in fecal sludge management; the fecal sludge extraction and transportation operators who gave us some of their time during interviews.

Disclaimers

The analysis and conclusions presented in this document are the responsibility of the authors and do not necessarily reflect the positions of the Bill and Melinda Gates Foundation or its partner institutions.

Acronyms

ADB	Asian Development Bank
AFD	French Development Agency
AIMF	International Association of French-speaking Mayors
AIRF	International Association for Regional French-speaking Mayors
Apsara	Authority for protection and coordination of Angkor Temple Site
AusAID	Australian Agency for International Development
COMPED	Cambodian Education and Waste Management Organization
CfD	Center for Development
ETO	Extraction & Transportation Operators
PDPWT	Provincial Department of Public Works and Transport
PDIME	Provincial Department of Industry, Mines and Energy
PDoE	Provincial Department of Environment
PPWSA	Phnom Penh Water Supply Authority
JICA	Japanese International Cooperation Agency
KOICA	Korean International Cooperation Agency
KWS	Kampot Water Supply
SRWS	Siem Reap Water Supply
FS	Fecal Sludge
FSM	Fecal Sludge Management
HH	Household
MIME	Ministry of Industry Mines and Energy
MPWT	Ministry of Public Works and Transport
FSTP	Fecal Sludge Treatment Plant
FSDS	Fecal Sludge Dumping Site

Abbreviations

Riels	Riels
USD	United State Dollars
ER	Exchange Rate 4,000 Riels = 1 US$
m^3	Cubic Meter
l	Liter
COD	Chemical Oxygen Demand
BOD	Biological Oxygen Demand

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ABSTRACT

Over the last two decades, Cambodia has experienced a rapid development but still faces numerous challenges, one of them being sanitation. While the access to improved sanitation reached 29% of the total population in 2008, there are large gaps between rural areas, where access to improved sanitation are low, and urban areas, where access to sanitation is high (80%), but where fecal sludge management coverage is low and problematic, causing environmental and public health threats and issues.

In order to better understand Fecal Sludge Management, the Bill & Melinda Gates Foundation commissioned the Gret to perform an assessment of the fecal sludge business models and practices in Cambodia. This document is a synthesis of key findings and presents the methodology performed, main results and recommendations to move forward.

This study was implemented in three cities: Kampot, Siem Reap and Phnom Penh in order to gather data and to acquire a detailed understanding of the situation on services providers, users and stakeholders involved in this sector. Three main topics were particularly analyzed:

- The **institutional environment situations** and the potential barriers to enter and regulates the market through meetings with various public and private institutions and NGOs involved in the sector;
- The **nature of the market** such as: demand, willingness to pay, practices and behaviors of existing and potential customers through a household survey;
- The **performances, constraints and opportunities of fecal sludge service providers** through the identification and interviews of public and private fecal sludge operators.

National strategies, policies and responsibilities of ministries exist and are quite clear on fecal sludge management but there remains **some overlaps among them**. However, their enforcement appears even more controversial due to the involvement of public institutions in the fecal sludge management sector is currently low. **If extraction and transport practices are known by public authorities, the treatment of sludge is largely less managed or controlled by them**. Consequently, the current situation raises an **alarming problem for public health and environmental** protection and require urgent intervention both at national and local levels.

Based on the three cities cases studies, living conditions in the three towns present similarities (number of people per households) and differences (smaller housing and

more people in shared buildings in Phnom Penh, lower proportion of well-off households in small and medium towns). Inequalities seem less important in Phnom Penh than in Siem Reap.

In general, **urban sanitation coverage is characterized by a high rate of equipment in domestic assets** (various types of latrine for a total coverage of at least 90% in each town); a variable access to sewerage systems (86% for Phnom Penh against 32% in Siem Reap and 40% in Kampot) and a variety of sludge storage facilities (latrine pits, septic tanks, etc.). However, **the proportion of households in the total sample having emptied their feces tank is really low** in each city: only 21% in Phnom Penh, 14% in Siem Reap and 19% in Kampot. Though, **the fees paid by the households are quite cheap** varying between 20USD for a mechanical ETO in Siem Reap to 50$ in Phnom Penh (25USD as an average). Fees are however negotiated individually based on the volume of sludge to empty and the distance travelled by the truck.

The market for domestic latrine emptying is quite diversified according the cities sizes but **the FSM service is mainly delivered and dominated by "private" mechanical ETOs in large and medium cities** while in small cities, demand is not yet sufficient to make this kind of business profitable. Consequently, **manual operators play a significant role compare to mechanical operator in small cities.** In opposition, in medium and large cities, manual operators are marginal and almost absent on the market.

Most mechanical ETOs are small enterprises owning one truck with two to three staffs. Interestingly, it appears that is **no scaling economy on this business** based on the number of trucks. Indeed, their productivity, measured by the number of clients per truck per year, can vary a lot related to the profile of operators:

- Type 1 - "Survivors" (from 1 to 150 customers per year) who make on average 2,400 USD per year profit; they have a mitigation risk strategy paying their staff on variable charges. In Siem Reap, most of them have this occupation as a secondary occupation.
- Type 2 - "Competitors" (from 150 to 350 customers) whose profit can be from less than 1,000 to 1,800 USD per year per truck; they are old operators having in general two or three trucks and have lost a part of their customers to new operators emerging as observed in Phnom Penh;
- Type 3 - "Performers" dealing with more than 350 customers and earning from 4,000 to 20,000 USD per year and per truck profit.

The **performers are usually more competitive thanks to their aggressive marketing strategy,** this type 3 includes the most dynamic operators and may be the only ones who will survive from this competitive market at long term view. **The E&T activity is characterized by high operational costs** (gasoline and human resources are the main ones). The study show that fees are not so different from one operator to another and depend on the negotiation with the customer**. Financial constraints for investment do not appear as a major constraint due to low market barriers entry costs** (12 000 USD for a locally assembled truck). **Technical constraints are also not quoted as one problem** as locally assembled trucks allow easy maintenance and

access to spare parts whenever they are needed. **The main constraints applying to operators seem to be business ones due to an important competition between operators and a rather low demand in Cambodian cities.**

Based on this analysis, five main recommendations are proposed in order to improve, optimize services quality, efficiency and effectiveness on Fecal Sludge Management sector in Cambodia:

1) To support National authorities to implement Policy dialogue and sector regulation

The sanitation institutional and regulatory framework is quite clear in urban areas of Cambodia. However, for specific fecal sludge management sector overlapping responsibilities remain among the MPWT, the MoE and urban planning on the licensing process and on control and regulation of fecal sludge activities. This fact seems to have negative impacts on sector development. There is no systematic control to enter in this activity from the authorities, resulting in the easy creation of businesses, but in the case of Phnom Penh this has created a saturated market compared to limited demand.

Practical actions to be implemented should include:

- ***Creating a clear framework for licensing and to control service quality ;***
- ***Allocating more financial and human resources for controlling the ETOs.***

2) To increase demand and develop "pre-treatment" technologies for households

The current population density in Cambodian urban areas is a high source of pollution mainly due to the poor design and quality of sanitation system in towns. Consequently, most of fecal sludge in urban areas is directly discharged to the environment without any treatment. Flooding risk is also the most important problem of urban sanitation, large combined drainage system that are currently employed is certainly the most efficient and effective paradigm for Cambodia. However, the development and promotion of high quality pre-treatment assets would be an efficient complementary solution to limit the impacts on the environment with only pre-treated wastewater discharge in the drainage system and Fecal Sludge collected by the ETOs.

Practical actions to follow this recommendation include:

- ***Improving sanitation products and adopt construction standards;***
- ***Improving production processes to decrease the operation costs per unit constructed and installed;***
- ***Facilitating access to finance to HH and strengthening business management skills, especially on marketing and promotion.***

3) In large cities, develop decentralized sludge treatment systems but let the market forces influence the behaviors

The treatment of the sludge collected is an obvious priority and the implementation of decentralized treatment would reduce the negative impact to the environment as well as it could help to reduce transportation costs. Indeed transportation costs are the highest of the emptying costs and the market structure shows that there are no clear coverage areas that are dedicated to ETOs: that can imply higher energy costs due to long transportation. Based on the study, it seems that market competition has positive effect by reducing fecal sludge tariff. It seems important to let the market forces come. However, investing in decentralized fecal sludge treatment plants can force to relocate the operators trucks in strategic places by optimizing the transportation costs and reducing at the end the final cost for the customers and to protect in the same time environment.

Practical actions to be implemented to support this recommendation include:

- ***Promoting and developing low-cost sludge treatment plant for ETOs;***
- ***Defining maximum tariff but let the market forces aplly;***
- ***Strictly control the service quality of ETOs.***

4) In small cities, to support manual operators to adopt semi-mechanized technologies

The case of Kampot shows that the FSM market is very low and does not yet allow running a mechanical E&T service like in Phnom Penh or Siem Reap. Manual operators can play a strong role as they already cover a big part of the market but their working conditions must be improved to increase their efficiency as well as to control the health risk that is currently very high as they are directly in contact with the fecal sludge. Finally, simple treatment options (burying sludge, drying beds, etc.) could be an efficient solution for small cities and should be developed to avoid any future problem in the town.

To support this recommendation, the following activities should be implemented:

- ***Improving the working equipment of manual operators;***
- ***Promoting simple sludge treatment technologies.***

5) Promote public awareness and environmental protection

Access to sanitation in urban areas is quite high however systems are often of low environmental quality and encounter problems. Raising awareness of the population could support the increase of demand for quality sanitation equipment and services. However, this has to be supported in parallel with the development of simple and affordable technologies.

Supporting this recommendation would require the following actions to be implemented:

- ***Informing and raising awareness of the population on sanitation value chain and its impacts on environment and public health;***
- ***Promoting safe urban sanitation;***
- ***Developing access to credit (and micro-credit) for dedicated eco-friendly equipment.***

PART. I – STUDY BACKGROUND AND METHODOLOGY

I. OVERVIEW OF URBAN SANITATION

Brief overview of Cambodia

The Kingdom of Cambodia is located in South-East Asia having a western border with Thailand, a northern one with Lao PDR and an eastern one with Vietnam. According to the last national census conducted in 2008, the country population is about 13.8 Million (NIS 2008). Over the past 10 years, Cambodia has experienced high economic growth and an improvement of living conditions thanks to the development of the global and sub-regional market particularly expressed through the progress of tourism and the increase of textile manufactories in the capital Phnom Penh.

Total Population	**13.8 millions**
Rural Population (%)	80%
Urban Population (%)	20%
Annual Population growth	1.9%
GDP per capita (US$)	447
GDP per capita (PPP)	2929

However, Cambodia remains characterized by economic activities focused on agricultural production and small business activities. Few industries exist and they generally are concentrated in Phnom Penh. Furthermore, over 80% of the population live in rural areas only the remaining 20% live in urban areas.

Other than Phnom Penh with its 1.3 million inhabitants, cities in Cambodia can be considered small cities. The second city of the country (Siem Reap) has only 170,000 inhabitants and most of the other cities have fewer than 50,000 inhabitants. Since the early 1990s, Cambodia has managed to make impressive improvements in reducing poverty, rebuilding the water and sanitation sector, and extending water supply to an increasing number of its population.

Urban sanitation: high coverage

Although significant efforts were made by Cambodia government, there is still a high number of people that has no access to improved sanitation. The latest figures from the Joint Monitoring Program (JMP, 2010)[1] for Cambodia continue to show low coverage rates for rural sanitation. Indeed in 2010, only about 31% of the total Cambodian population had access to improved sanitation. The Royal Government of Cambodia (RGC) has taken steps to address this issue and has recently started to implement a clear strategy to support and develop access to sanitation in rural areas.

On the contrary, the access to "improved" sanitation is quite high in urban and peri-urban areas even if statistic sources can vary a lot following data and study sources. When the National Census in 2008 shows that the rates are close to 80% (56% through sewer connections, 40% through septic tanks, 3% through latrines and 1% others), the Cambodia Demographic and Health Survey (NIS 2005) show that in urban areas the average number of households (HH) connected to sewers is about 28.9%, to a septic tank 25.8%, to a pit latrine 1.4%. Indeed, it appears that the improved sanitation coverage varies from 56.1% to 61.1 % following the data available taken into account. According the Economic Impacts of Sanitation study (Kov P. 2008) there is an unclear vision of the sector situation.

Urban sanitation: but low quality of systems

In the core of major Cambodian cities most urban sanitation systems, when they exist, are based on centralized approaches linking drainage, wastewater collection and treatment. Pre-treatment is very common both in the core and peri-urban areas before discharging wastewater in sewerage systems composed of sewers and open canals. For households located outside the sanitation service coverage area, on-site systems are most common. However, in urban areas, the Cambodian water and sanitation sector is characterized by systems that provide water supply services to the population without providing sewerage and sanitation services (PPIAF and WB, 2002).

Regarding more specifically the sanitation sector, there are only a few sanitation projects in urban and peri-urban areas. Although the institutional framework is rather clear, its definition of responsibilities and boundaries between public health issues, drainage and sanitation management is insufficient. The Ministry of Public Works and Transport is responsible for sanitation service delivery, but it has shown low investment capacity and limited skills to establish and manage utilities. Actual urban sanitation conditions are very poor due to poorly designed sanitation systems with often no or limited treatment or pre-treatment of effluent. Fecal sludge is generally dumped in the environment without any safe treatment. There is thus a growing concern for urban pollution of groundwater, serious environmental damage and public health issues.

The significant involvement of private sector in sanitation

In Cambodia, there are many SMEs who are active in the urban sanitation sector. Along the urban sanitation value-chain, SMEs are: sanitation systems designers, producers,

[1] http://www.wssinfo.org/data-estimates/table/

importers, retailers, builders and masons, pit and tank emptiers, re-users and recyclers, etc. Studies show that the SMEs are already delivering most of sanitation systems in Cambodia (Roberts, Tanner et McNaughton, 2007).

Few are dedicated to sanitation (mechanical emptiers for instance), most are occasionally involved in the chain (architects, masons, small construction companies, real estate developers). However, the upstream part of the sanitation value-chain is characterized by low quality products (combined sewers, septic tanks and latrines) neither coherent nor designed using a holistic approach. Downstream of the sanitation value-chain, SMEs (emptying systems, sludge re-use for farming) remain mainly unstructured and informal.

An ignorance of Fecal Sludge Management in Cambodia

If many stakeholders have paid attention to the access to sanitation growth rate, fewer organizations have offered a comprehensive analysis of the extraction and transportation of fecal sludge in Cambodia. Few in-depth and global surveys and analysis have yet been conducted.

However, many SMEs, either manual or mechanical ETOs, latrine builders or other "informal" stakeholders are active in this sector. They are working day to day to build and disseminate sanitation products and services. They play a great role which is not yet recognized:

- They provide a complementary service to households who cannot afford being connected to a piped sewage system;
- These systems are flexible, adaptable and affordable to the demand and they are providing employment and incomes to an unskilled population.

Within this framework, the Bill and Melinda Gates Foundation has funded an in-depth survey of Fecal Sludge Management in Cambodia in order to provide a comprehensive analysis of the sector and to identify key recommendations and potential steps to move forward.

II. OBJECTIVES AND METHODOLOGY

1. KEY OBJECTIVES OF THE STUDY

The "Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Cambodia" aims to gather and rigorously analyze data based on a representative range of criteria to better understand fecal sludge management in Cambodia and especially its extraction & transportation. It aims to better understand the living conditions of these operators, their technical, financial and economic situation, and the market size through a household survey. At a secondary level, it aims to provide key data and recommendations about the opportunities, constraints, conditions and potentiality of development of these markets in a prospective analysis.

2. SURVEY METHODOLOGY

2.1 City sample

In order to select the three cities surveyed that are representatives of urban conditions in Cambodia, the following criteria were applied: i) total population, the "size": the capital of Cambodia, one medium-sized city and one small-sized city; ii) geographical location: one city in the center of the country; one city in the north and one city in the south; iii) environment specificity: one city along the Mekong River; one city in the Mekong basin and one city close to the sea. These criteria aim to select different types of physical, environmental, socio-economical characteristics. Three cities have thus been selected: Phnom Penh, a large city (1,33 Million inhabitants), Siem Reap as a medium one (168 700 inhabitants) and Kampot as a small city (38 800 inhabitants).

Table 1 – Trend of population on targeted cities

Name of city	Name of province	Population (census 1998)	Population (census 2008)	Growth (%)
Phnom Penh	Phnom Penh	950,373	1,327,615	72%
Siem Reap	Siem Reap	97,105	168,662	42%
Kampot	Kampot	36,036	38,819	7%

2.2 Customer survey methodology

- Determination of the sample size

The household survey sampling was based on the number of population and a transect approach in each city. The transect approach has been considered as the most appropriate in the specific case of Cambodian cities due to the strong geographical heterogeneities of socio-economical and sanitation data of these cities. Indeed, this approach, if it is well-managed, can represent a slice of a city which includes the variety of situations along one transect and consequently can reduce the normal bias of socio-economic analysis. The total number of household surveys to be conducted was defined following the table below using an average number of inhabitants per household of 5.1 based on the General Population Census 2008 (NIS 2008).

Table 2 – Survey Distribution per cities

Name of the city	Number of population	Number of HH	HH in transect selected	Number of survey	% per transec
Phnom Penh (without Takeo province)	1,242,992	243,724	65,974	1,320	2.0%
Siem Reap	168,662	33,071	10,768	428	3.96%
Kampot	38,819	7,612	5,137	308	5.90%

The number of HH survey to be conducted was based on the population density in each commune (with the same surface area on average) along transect. In Phnom Penh, two transects were defined and only one in Siem Reap and Kampot.

- Evaluation of the socio-economic status

In order to determine the socio-economic status of the households, many criteria were checked at the beginning: i) the detailed expenses, ii) the incomes of the first and the second worker in the house; iii) the qualitative perception of the evaluator, iv) the income per day per capita calculated and v) the detention of some specific assets. Every criterion was tested and compared to evaluate the level wealth of the HH. The last one, the detention of assets gave us a close proxy of each criterion and was the one we kept for the analysis.

An indicial number was created per points according the assets that the HH owned: i) means of transport (number of bicycle, motorcycle, car per HH), ii) number of phones per HH; iii) number of computers per HH and; iv) type of energy used for cooking. Following these criteria, points were attributed to each HH. Gret assumes that from 0 to 15 points, the HH can be considered as a poor, from 15 to 30 points as a medium and more than 30 points for the HH considered as well-off.

2.3 ETO survey & market analysis methodology

- ETOs survey methodology

The survey and sampling of extraction & transportation operators (ETOs) was done in two steps: i) pre-screen survey in order to try to identify all ETOs both manual and mechanical; ii) a sampling of operator type identified during the pre-screen survey; iii) an in-depth analysis of each type of ETO based on a sampling from the pre-screen survey. The following typology of operators has been used: i) public ETOs; ii) private ETOs: small ETOs, medium ETOs, large ETOs; iii) manual ETOs. The sampling of the operators is given in the table below:

Table 3 – Pre-screen sampling of ETOs in Cambodia

		Type	# of operators	# of operators surveyed	%
Manual E&T operator	Phnom Penh		24	5	21%
	Kampot		1	1	100%
Mechanical E&T operator	Phnom Penh	Small	12	5	42%
		Medium	7	6	86%
	Siem Reap	Small	5	4	80%
		Medium	1	0	0%
	Kampot	Small	1	1	100%

- Fecal sludge production and market estimation

In order to calculate the fecal sludge production, two methodologies were tested: i) frequency and volume declared in the survey were applied to each kind of assets; ii) a theoretical approach by fixing the production of sludge per capita per year produced. To set this parameter and determine this production, we calculated the ratio for each asset of those who emptied. This gave us a theoretical number of sludge produced per asset per capita: an average of 0.06 m^3/year/capita produced. We applied this criterion then to calculate the fecal sludge production in each city.

To estimate future demand, according to our survey, the following hypothesis was made: we supposed that the frequency of emptying will not change in the future and that the people who have the same assets and technological profile will empty at a same proportion than those who already emptied once.

We have to notice that there are important biases in the calculation of the future market. They are due to the fact that we don't really know why an individual HH decides to empty or not.

III. FECAL SLUDGE MANAGEMENT OVERVIEW

1. INSTITUTIONAL OVERVIEW

1.1 Many ministries involved in the sector

- Sanitation Sector vision

The sector vision is based on: "Every person in rural communities has sustained access to safe water supply and sanitation services and lives in a hygienic environment by 2025" (CMDG).The main principles promoted are: 1) The sustainability of improved sanitation facilities and hygiene behavior; 2) Community-based management; 3) Demand responsive approach; 4) Sanitation financing without hardware subsidies (Okelford, 2010).

Currently, the first priorities for the MPWT for wastewater and sanitation development are Phnom Penh, Siem Reap, Sihanoukville and in second, Kampot, Koh Khong, Battambang and Kratie (Pisith, 2008).

- National level

Urban sanitation is an issue that involves many stakeholders and in which the responsibilities are shared between many ministries, agencies or local authorities. Urban sanitation is related to environmental issues as well as health, land planning or water resource protection issues. In Cambodia, several ministries are involved in urban sanitation but four ministries are predominant:

i) The MPWT is responsible for urban drainage and sanitation in urban areas of Cambodia including the Phnom Penh Municipality;

ii) The Ministry of Environment (MoE) is in charge of water pollution control and environmental protection: the MoE was established in 1993 with the mandate to protect and upgrade environmental quality and public health through prevention, reduction and pollution control measures. It inspects pollution sources in collaboration with concerned institutions, issues fines, and/or compiles information for authorized institutions;

iii) The Ministry of Land Management and Urban Planning (MoLMUP) is responsible for construction standard control and issuing construction permits;

iv) The Ministry of Industry Mines and Energy (MIME) is responsible for urban sanitation at the household level;

v) The Ministry of Water Resources and Meteorology (MoWRAM) was established in 1999 to define the policies for strategic development of water resources. It currently has a limited role in the water sector and focuses mainly on granting water abstraction rights;

vi) The Ministry of Rural Development (MRD) is responsible for rural sanitation (latrine construction and standards) conforming to the national strategy for water and sanitation adopted in 2003.

1.2 A light legal framework

The main legal documents that frame urban sanitation are: the Environmental Protection Law (1996), the Sub-decree on Construction Permits (1997), the Sub-decree on Water Pollution Control (1999), the National Water and Sanitation Policy (2003) and recently the Rural Water Supply, Sanitation and Hygiene Strategy: 2010-2025 (2010).

- National Policy on water supply and sanitation 2003

In 2003, the Cambodian government issued a National Policy on Water Supply and Sanitation, a "key crucial factor for setting up an institution that can maintain and expand the services" that is the only document that frames urban sanitation. However, there is not yet a strategic plan, political agenda and law in order to enforce and detail this policy.

The National Policy on Water Supply and Sanitation consists in three parts: urban water supply, urban sanitation and rural water supply and sanitation. The policy promotes the construction of "community sanitation systems, [where] all residents share in financing the systems, whether they use them or not". The scale of application of these criteria is the "neighborhood sanitation block" (household conglomerates). These "community sanitation systems" are then supposed to be discharging into either a decentralized treatment facility or into "zonal sanitation systems" (public sewerage), where "the use of separate sewerage and drainage systems should be promoted and encouraged, particularly in new installation areas."

The document identifies the need to "separate responsibilities" (operation, regulation) among "the Ministry, other responsible ministries and local authorities", without naming any of them. However, "Municipal and Provincial authorities are responsible for urban sanitation". The last chapter of the document is explicitly focusing on "expanding service to the poor". However, guidelines do not consider non-sewer solutions, and only look for financing mechanisms, including "target subsidies in exceptional circumstances" (Kopitopoulos 2005).

- Water pollution control

The MoE should control the effluents that are discharged and their conformity with the standards enacted (1999). In terms of regulatory framework, some legislative texts complete this national policy, there exists at the national level a few laws and sub-decrees on water pollution control or on solid waste management. These texts give clues about sector principles: i) effluent standards and norms of pollution enacted follow international standards; ii) the polluter is the payer: the source of pollution is responsible for the treatment of effluent; iii) the approach is centralized with the willingness to install combined sewers in all the urban areas and connect all the HH, not taking into account the specificity of the cities or even the feasibility of those networks, their maintenance and operation.

- License delivery

According to law fecal sludge ETOs should apply to three different permits or licenses issued by different ministries:

i) The MoE shall deliver a license for the discharge or transportation of effluent when the amount of their effluent exceeds ten cubic meters per day not including the amount of water used to cool the engine;

ii) The MPWT is in charge of delivering a license for vehicles and control the "use of the vehicle"; the MPWT is also in charge of urban sanitation (and sometimes in direct competition with private operators);

iii) The MIME delivers licenses in the water sector of the draft law on water and sanitation will be applied but could deliver also licenses in the sanitation sector; the definition of sanitation services appears clearly in article 35 "The right to provide sanitation service in this law is the right of ownership, operation and managing facilities to collect, discharge and treat sewerage for insure of the safe, reliable, and economic efficient operation". In article 31, licenses can be delivered for "4- Sanitation Service License, 5- Wastewater Discharge Collection License and finally 6- Sewerage Treatment License."

Figure 1 – Urban sanitation, enviromental protection and solidwaste management laws

Source : **Cambodia Environmental Health Country Profile, World Health Organization, As of December 3, 2004**

1.3 Other key stakeholders

- Funding agencies and programs

In urban areas surveyed, the JICA and AFD have funded the definition of master plans (respectively in Phnom Penh and Siem Reap) on wastewater collection and drainage systems. The Korean Cooperation Agency is acting through Korean private actors (bank and consulting firms) to install some piped networks through important loans (one approved in Siem Reap and another in Kampot but has been postponed). Moreover, very few NGOs are active in the sector. Indeed, only one, Center for Development (CfD) is focused on urban sanitation.

- Financing institution

The banking sector in Cambodia is characterized by a lack of involvement in financing SMEs, especially in the sanitation sector. There are several micro finance institutions (MFIs): Amret, Ank, Vision Fund; and several commercial banks: Acleda, ANZ, Campu, etc. However, the banking sector in Cambodia is unfortunately extremely conservative in its attitude to risk. Many SMEs mentioned that they could not access finance to expand or improve their operations or to invest in capital investment. From the household and business side, MFIs are “conformist” and do not want to propose micro-credit for investments that are wrongfully considered “unproductive”.

2. VALUE-CHAIN DESCRIPTION

The FS value-chain starts with demand from households for different types of works required: emptying their treatment assets which are overflowing or just full or cleaning the sewer lines on tertiary roads. They are several kinds of stakeholders that are involved in the E&T value-chain of: i) truck assemblers; ii) public mechanical ETOs; private ETOs that can be small (only one truck), medium (from 2 to 4 trucks) or large

(more than 4 trucks)[2]; iii) manual ETOs; iv) fecal sludge re-users; v) authorized fecal sludge dumping site; “un-authorized” fecal sludge dumping site.

2.1 A large range of technologies for collection

- On-site sanitation and pretreatment

Following the Cambodia Demographic and Health Survey (NIS 2005), Phnom Penh has a high rate of HH connected to the sewer when medium-sized and small cities use more septic tank and other on-site sanitation systems. However, behind this standard data there is a large range of technological solutions that are used commonly in Cambodia. The part below aims to present an overview of each solution that will be used after in the analysis of household practices and technical assets description.

Unfortunately, in Cambodia, there are no technical specifications on sanitation collection, transport and treatment assets. Nevertheless, some “standard designs” are often used by latrine installers such as: i) multi-storey buildings are connected directly to combined sewerage systems or to septic-tanks if they are far from the network; ii) certain middle standard households use “septic tanks” but most use pit systems either discharging directly into the drainage system (sewerage or open-air channels) or infiltrating to the ground through sump holes; iii) urban poor or HH which have no sewage system use traditional pour-flush latrines. There also are a lot of SMEs who manufacture sanitation assets made of concrete, but plastic assets are normally imported.

The sanitation systems connected to the sewer often discharge pretreated wastewater without solids. The sullage (gray water) is often discharged directly into the channel or combined sewage system.

[2] This methodology has been proposed in order to classify the ETOs, it will be used on the following city study case along the analysis.

- Type 1 – One pit connected to the sewer or not connected to the sewer

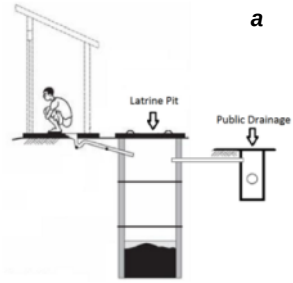
The first type of sanitation system that can be found very often in cities is the standard one pit latrine system that is connected to a sewer or that discharges directly into the street (Fig. a) or into the environment or infiltrates (Fig.b). Sometimes there is a connection-box or interceptor tank (volume 100l) between the pit and the sewer.

The pit is rarely sealed at the bottom so that can permit the infiltration of wastewater into the ground.

This first stage can be named “pre-treatment” tank. Consequently, only supernatant is discharged into the secondary sewer system or into the environment. The absence of a deflector can, in some cases, reduce the pre-treatment undergone by the sludge before discharge.

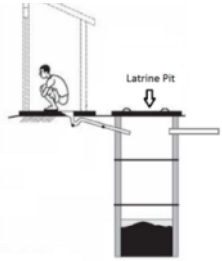
The pit is composed by three concrete rings with a diameter of 0.90 meters. The total average volume is estimated ranging from **0.75 cubic meters to 1.5 cubic meters.**

a



Option 01: Latrine with single pit

b



Option 01: Latrine with single pit

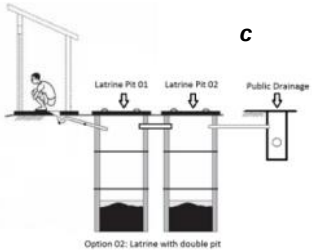
- Type 2 – Pits in series connected to the sewer or infiltrating

The second type of sanitation system is composed by a series of pits that are linked by pipe. They can have from 2 to 4 pits at the maximum. As the first pit system these systems can be connected to the sewer or discharge directly into the street (Fig. c) or the environment or infiltrate (Fig. d).

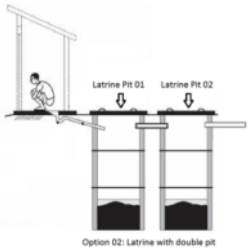
As the first pit system, the pit in series system is not sealed at the bottom so that allow infiltration of wastewater into the ground. The system presents the same problem on discharging fecal sludge into the environment or in the secondary sewer. The pit is composed from 2 to 4 pits by three concrete rings with diameter of 0.90 meters.

The total average volume is estimated from **1.5 cubic meters to 3 cubic meters.**

c



d



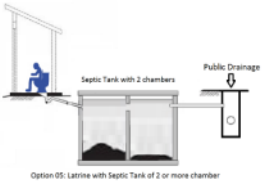
- Type 3 – Septic tank/stock tank connected to the sewer or infiltrating

The third type of sanitation system is real septic tank because of a seal at the bottom that avoids infiltration into the environment. Most of them were built under the French colony during the 50s. News ones made of plastic have recently been introduced in Cambodia but these kind of system are anecdotic. As the other sanitation systems the two main wastewater evacuation methods are: connection to the sewer or discharge directly into the street (fig.e), the environment or infiltration (fig.f).

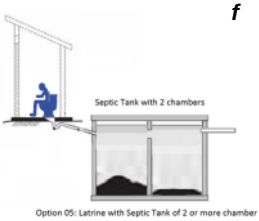
As, the other systems if the technical specification are not respected (no deflector), feces can be discharged by an overflow into the sewer or in the environment. Generally only the treated supernatant can be discharged.

This system is composed by two chambers as a real septic tank with two stages of pretreatment. The average volume is estimated from **2 to 3 cubic meters.**

e



f



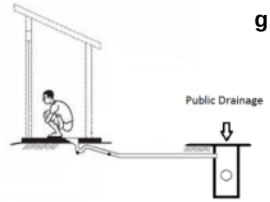
- Type 4 – Direct connection to the sewer or no storage assets

Few households have a direct connection to the sewer (fig.g) without any pretreatment/storage stage like an off-site system.

In theory these systems do not require any E&T services but sludge accumulates at the bottom of manholes. These systems often exist in the core of Cambodian cities.

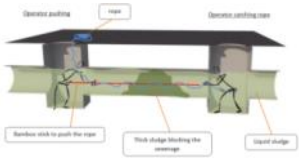
Finally, these system need to be emptied sometimes when the manhole (fig.h) are block with too much fecal sludge or by solid waste and others solid materials.

g



Option 06: Direction connection to Public Drainage

h



- Sewerage systems

The sewerage systems installed in Cambodia are combined systems that collect wastewater and rainwater. They are often composed of: i) a secondary sewer system; ii) a primary open-channel system. The effluents are then sent through pumping stations to wetlands that treat them.

In the street, HH sanitation systems are connected to a closed sewer that collects both rainwater and wastewater. These sewers are often blocked due to solid waste and other materials that enter the sewer during the rainy season. This causes flooding problems for the inhabitants living in urban areas.

The secondary sewers discharge the wastewater and rainwater into big open canals that drain the cities to several points. They transport the wastewater to lift stations located close to wetlands or lagoons that can treat the wastewater.

A simplified distinction between on-site sanitation (septic tank and pit latrine) and off-site sanitation (sewer system without "pre-collection") is not relevant in the Cambodian context.

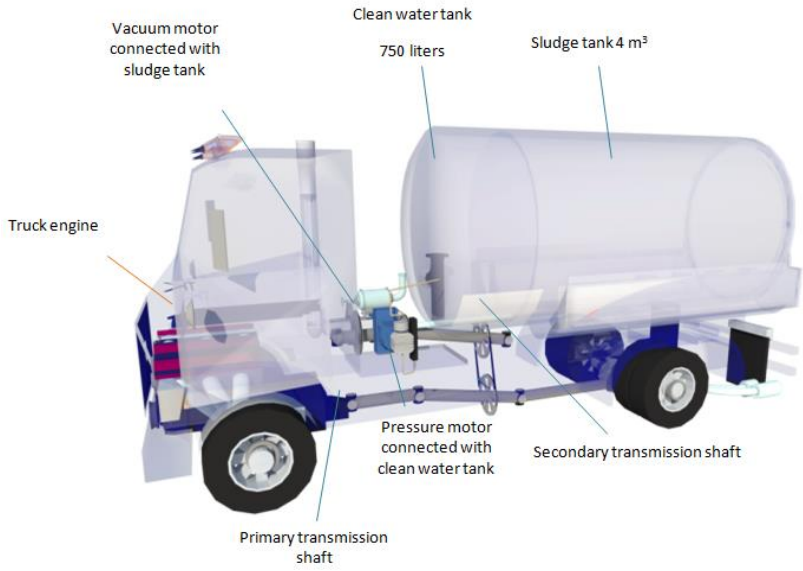
2.2 A large range of stakeholders in Extraction and Transportation chain

- Truck assemblers

There are two truck assemblers in Phnom Penh and one in Siem Reap. The oldest one, started his business in 1993, has built around 50 trucks whose owners are distributed throughout Cambodia.

It seems that they have built most of the emptying systems existing in Cambodia. In general, the truck equipment is home-made with second-hand materials built by the operators described above. A wide range of types of truck is used. The advantage of local assemblers is their flexibility: the maintenance can be done locally, the tank size can be chosen, and the tank can be changed without changing the engine. The trucks are equipped with two different types of pipes, one for water and one for pumping. They have to be changed every two or three years. The second hand trucks come from Korea or China.

Figure 2 – Standard truck design in Phnom Penh



- Public Extraction & Transportation Operators

Public mechanical ETOs are managed in general by the DPWT through the municipalities in order to **operate and maintain the primary sanitation systems of the cities.** There are public ETOs in Phnom Penh and in Siem Reap which have respectively 10 trucks and 1 truck. The trucks are imported and come from Europe, Russia or Japan.

These trucks are in charge of the maintenance of the sewerage systems both in Phnom Penh and Siem Reap. They do not desludge at the household level. When a district has a problem in their area, they call the DPWT who will then establish a proposal for the Phnom Penh authorities. Most of the time this proposal is accepted and they can start the work of deblocking sewerage pipes, or changing the pipe if necessary. This truck is operated ideally by 4 people but 2 people are enough.

- Mechanical private ETOs

Private mechanical ETOs dominate the HH emptying market. In general, these family-scale businesses run trucks that empty septic tanks, latrines or clean sewers. They are both informal and formal. They run from 1 to 4 trucks but small operators are predominant (one truck)

They discharge the sludge in the required authorized dumping site, but it seems that a large part of them discharge directly to the environment without sludge treatment.

The tanks have different sizes depending on the city: from 3 m^3 in Siem Reap, 5 m^3 to 8 m^3 in Phnom Penh and Kampot. According one truck assembler, a common system without the truck (5 m^3 sludge tank and 1 m^3 clean water tank, two pumps) is usually sold from 15,000 US$ to 20,000 US$. Then the total cost depends on the quality of the truck.

The smaller trucks used in Siem Reap are cheaper on average, their cost varies from 12,000 US$ to 15,000 US$ also depending on the quality of the truck.

- Private Manual ETOs

Manual emptiers are mostly “informal” actors who work for a day to deslugde manually sewers or latrines. 50 manual emptiers were identified in Phnom Penh and 2 in Kampot but none was found in Siem Reap.

Private manual ETOs usually work in the construction sector with many activities including installing piped networks, cleaning the sewers, emptier of tanks and even plumbing repairs.

The manual desludgers of Phnom Penh can be divided into two categories. First the multitask workers waiting in dedicated places of the city (Stung Mean Chey/Tual Kork) who are ready for whatever work they are asked for, and on the other hand the *Ek Chai*, solid waste collectors of the city who offer their services in a more dynamic way, advertising their presence. In Kampot, the manual emptier works mainly in this domain.However, it is important to notice that all of them have different stories, different backgrounds and habits. The emptying activity is sometimes not their regular income source and sometimes is only part of their income.

- Re-users

Along the value chain, some small farmers use sludge as fertilizer. These practices are however very informal and difficult to measure. Many ETOs say that they occasionally resell the sludge in the countryside (for farmers to use as fertilizer for rice crop) through contact and relationships, but no clear practices were identified. They also say they do not dump sludge in the same place every

time.

- Dumping site

In Phnom Penh, there are three authorized dumping sites that are wetlands. Private ETOs pay 1.5 USD/dumping/trip. Public ETOs don’t have to pay and can discharge the liquid part of their load in the open canals across the city. In Siem Reap, there is a dedicated place to dump fecal sludge at wetland recently built by international donors.

Operators pay 1.5 USD/dumping/trip. In Kampot, there is no dumping site. However, in Phnom Penh if most ETOs said that they dump at the wetland the survey shows that only one really goes there. So, many unofficial dumping sites exist throughout the city.

PART. II - LANDSCAPE REVIEW OF FECAL SLUDGE MANAGEMENT IN CAMBODIA

I. OVERVIEW OF KEY FINDINGS

Based on the assessment of each city, a cross-check analysis was undertaken following the main information collected. Some key findings can be easily identified.

- Similar urban configuration and socio-economic organization

The number of persons per family is around 5. The number of persons per house is almost the same, about 6. In terms of housing and socio-economic profile, small and medium towns are also similar: these are mostly constituted by individual houses rather than by buildings. The poor and medium categories represent more than 90% of the entire sample, higher than the 79% in Phnom Penh. However, this conclusion masks many differences as inequalities seem less important in Phnom Penh than in Siem Reap.

Figure 3 : Comparison of incomes in each city

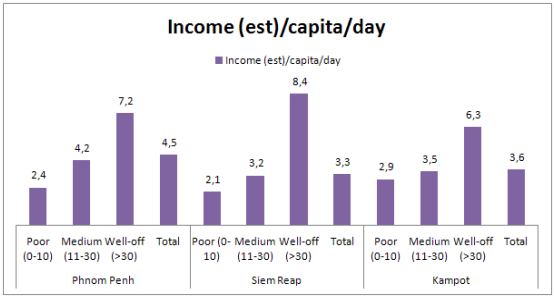
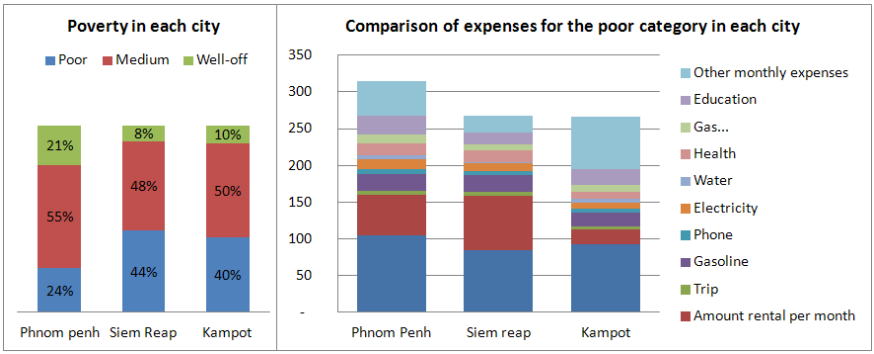
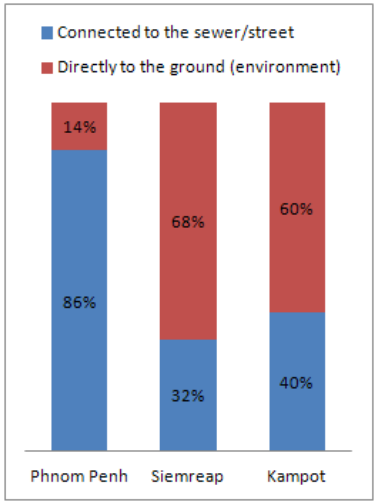


Figure 4 : Poverty and expenses of the poor in each city



- On-site versus off-site sanitation: an irrelevant approach in Cambodia

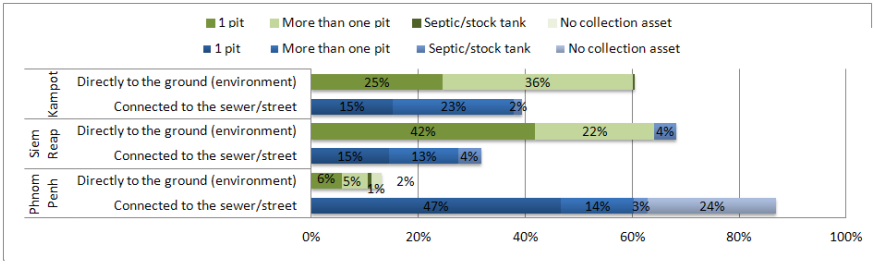
According to the survey, urban sanitation coverage is relatively high in the three cities surveyed, often close to 90%. However, the urban sanitation management model is not based on a difference between on-site and off-site sanitation. This division is not relevant.



Indeed, the Cambodian urban sanitation paradigm aims first at flood control, using in part open air drainage systems and then to collect wastewater. De facto, existing sewer systems follow this paradigm and function as settled sewers, the solid phase intercepted in pits or tanks with a form of pretreatment. Thus a typical urban sanitation system in Cambodia combines an on-site part (the pit or tank) and an off-site one (the sewer and drainage network). Considering only the treatment assets, most of the systems are constituted by infiltration pits (like in rural areas).

In Phnom Penh, the connection rate to the sewer is very high, up to 86%, whereas in small and medium towns, the rate is less around 35% (32 % in SR and 40% in Kampot). Moreover, in Phnom Penh, almost 26% of the HH have no treatment asset and are connected to the sewer directly (24%) whereas in Siem Reap or in Kampot, every HH has pretreatment assets on their land, this is linked both to the greater density of the Phnom Penh sewer and drainage network and to due to the availability of more space to install them in these towns.

Figure 5 – Evacuation modality and assets comparison

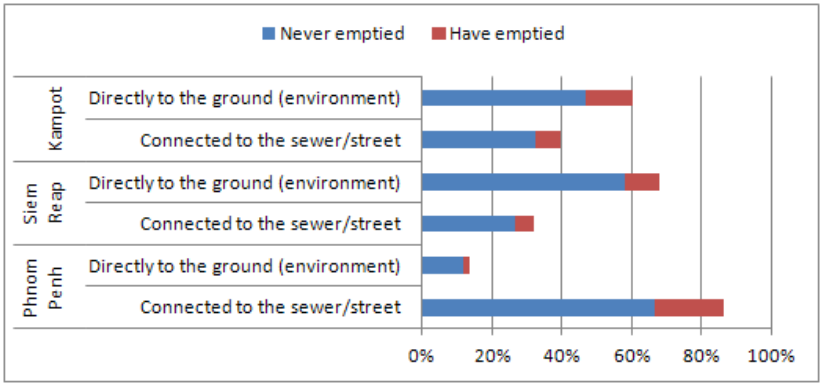


- Few emptying and more emptying on off-site sanitation than on-site sanitation…

What are the influences of technological assets on emptying practices? Emptying is barely practiced and the percentage of households having emptied their pits is homogeneous in the three cities: only 15% in Siem Reap, 21% in Kampot and 22% in Phnom Penh of the total number of households declared that they emptied at least once their pit or septic tank.

Surprisingly, there is no link between the type of sanitation assets and the emptying frequency. Indeed, in Phnom Penh, the HH who are connected to the sewer empty their assets more than the others, confirming the paradoxical "on-site / off-site" nature of Cambodian urban sanitation.

Figure 6 – Emptying practices and evacuation modality

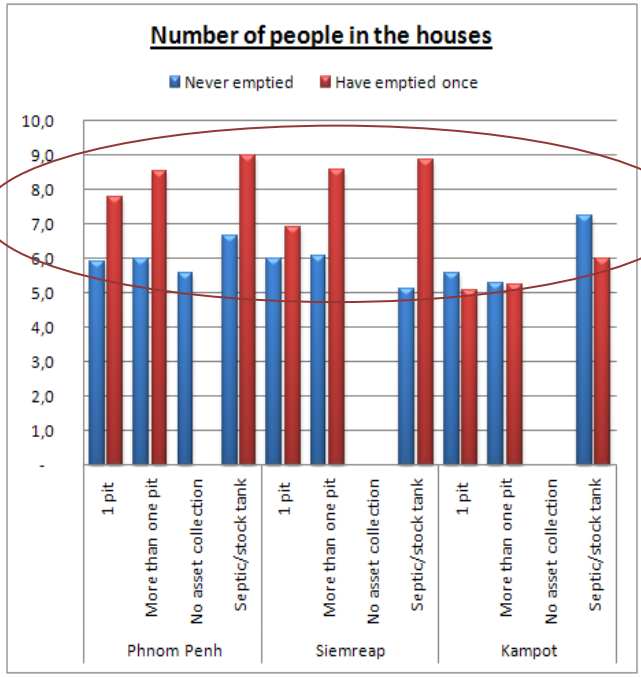


- A high correlation between emptying practices and the number of people using the assets

Finally, the main criterion to determine the reasons for emptying is related to the number of people in the houses. Indeed, the number of HH who have emptied their asset is highly correlated to the number of persons in the house.

As shown in figure 7, when this number is high we observe a higher amount of HH who have emptied their sanitation systems. It is particularly significant in Phnom Penh and Siem Reap, the HHs who have emptied have an average number of 8.1 people in the household in Phnom Penh and 7.9 in Siem Reap.

Figure 7 : Emptying practices and number of people using assets



II. MARKET AND BUSINESS MODEL ANALYSIS

1. COMPARATIVE ANALYSIS OF SERVICE DELIVERY

1.1 Fecal sludge production and market

- Current market in Phnom Penh

In Phnom Penh, the market is covered at 74% by private E&T operators, at 14% by HH themself and 7% by manual operators. It means that there is not a great potential for growth as only the 14% of new client that emptied themselves could be a target in the future. The current volume of fecal sludge collected is estimated at through the survey **25, 764 m³ per year** and the potential market is estimated at **92,941 m³ per year**.

The theoretical sludge collected is **26,979 m³ per year**. This is greater than the real fecal sludge production due to the fact that E&T operators cover a larger part than the administrative area of the city.

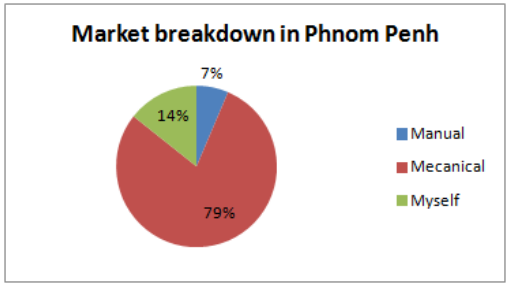


Table 4 – current and future market in Phnom Penh

Estimation of the role of FSM operators in Fecal Sludge Collected in Phnom Penh							
		Actual market (volume m3)			Future market (volume m3)		
		Manual	Mecanical	Myself	Manual	Mecanical	Myself
Type 1	Connected	1,269	12,492	2,830	4,577	45,063	10,209
	Directly to the ground	98	976	195	352	3,521	704
Type 2	Connected	293	4,489	488	1,056	16,194	1,760
	Directly to the ground	-	781	-	-	2,816	-
Type 3	Connected	-	878	98	-	3,168	352
	Directly to the ground	-	878	98	-	3,168	352
Total		**1,659**	**20,494**	**3,709**	**5,985**	**73,931**	**13,378**

- Potential market in Phnom Penh

The table put below aims to analyze the future market in Phnom Penh. Based on the capacity of the trucks the market is already covered at 77%.

Table 5 – Potential market in Phnom Penh

PRODUCTION per YEAR	
Based on survey data = P1	**25,764 m³**
Theoretical calc = P2	**92,941 m³**
Theoretical FS collected per year = C	**26,979 m³**
Based on survey average number of clients of mechanical op. per year	**574**
Based on survey average number of clients of manual op. per year	**48**
Theoretical capacity of trucks m³ (sludge part)	**4 m³**
Theoretical volume pumped m³ = C1	**71,176 m³**
Potential volume to be collected = C2	**21,765 m³**
Market coverage C2/P2	**77%**

- Current market in Siem Reap

The market in Siem Reap is drastically dominated by private E&T operators at 87%. Few HH empty their sanitation system themselves (14%). Based on our calculation, the actual volume of fecal sludge collected is estimated at **3,684 m³** per year. The potential market is estimated at **25,662 m³ per year**.

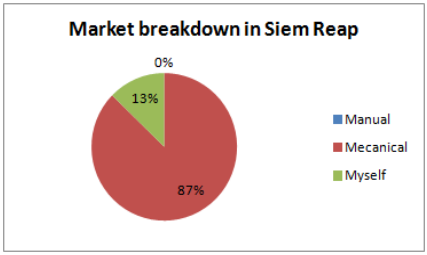


Table 6 – Current and future market in Siem Reap

Estimation of the role of FSM operators in Fecal Sludge Collected in Siem Reap							
		Actual market (volume m3)			Future market (volume m3)		
		Manual	Mecanical	Myself	Manual	Mecanical	Myself
Type 1	Connected	-	536	67	-	3,733	467
	Directly to the ground	-	938	67	-	6,532	467
Type 2	Connected	-	402	67	-	2,800	467
	Directly to the ground	-	737	335	-	5,132	2,333
Type 3	Connected	-	536	-	-	3,733	-
	Directly to the ground	-	536	-	-	3,733	-
Total		**-**	**3,684**	**536**	**-**	**25,662**	**3,733**

- Potential market in Siem Reap

The table below shows that the FSM market potential is more important in Siem Reap. Only 57% of the market is already covered and 11,015 m³ per year cannot currently be collected when the sanitation system will be full.

Table 7 – Potential Market in Siem Reap

PRODUCTION per YEAR	
Based on survey data = P1	**3,684 m³**
Theoretical calc = P2	**25,662 m³**
Theoretical FS collected per year =C	**2,520 m³**
Based on survey average number of clients of mechanical op. per year	**210**
Based on survey average number of client manual op. per year	**0**
Theoretical capacity of truck m³ (sludge part)	**2.25**
Theoretical volume pumped m³ = C1	**14,648 m³**
Potential Volume to be collected = C2	**11,015 m³**
Market Coveraqe C2/P2	**57%**

- Current market in Kampot

The market structure in Kampot is also different from the ones observed in Phnom Penh and Siem Reap. Mechanical E&T operators represent only 28% while 30% are manual operators. Most of the household empty themselves their sanitation systems. Based on our calculation, the actual volume of fecal sludge collected is estimated at **1,013 m³ per year**. The potential market is estimated at **4,890 m³ per year**. The table shown below presents the detailed results of the calculation.

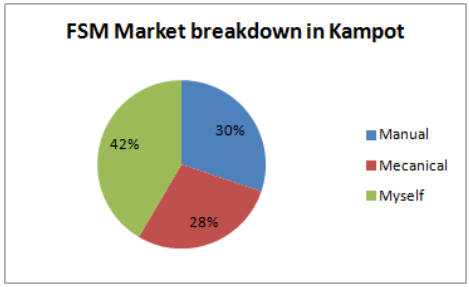


Table 8 – Current and future market in Kampot

Estimation of the role of FSM operators in Fecal Sludge Collected in Kampot							
		Actual market (volume m3)			Future market (volume m3)		
		Manual	Mecanical	Myself	Manual	Mecanical	Myself
Type 1	Connected	58	39	39	282	188	188
	Directly to the ground	97	58	175	470	282	846
Type 2	Connected	78	117	19	376	564	94
	Directly to the ground	78	78	156	376	376	752
Type 3	Connected	-	-	19	-	-	94
	Directly to the ground	-	-	19	-	-	94
Total		**312**	**292**	**429**	**1,504**	**1,410**	**2,069**

The market is already covered at 122% in Kampot due to the presence of one mechanical operator. However, this system seems to be inappropriate to Kampot context that does not generate a sufficient demand for a mechanical E&T and certainly

not for a 5 m^3 tank truck. The Siem Reap tank size would be better adapted, with 3 m^3 per truck tank.

Table 9 – Potential market in Kampot

PRODUCTION per YEAR	
Based on survey data = P1	**1,013**
Theoretical calc = P2	**4,890**
Theoretical FS collected per year =C	**260**
Based on survey average number of clients of mechanical op. per year	**48**
Based on survey average number of client manual op. per year	**60**
Theoretical capacity of truck m^3 (sludge part)	**4**
Theoretical volume pumped m^3 = C1	**5,952**
Potential Volume to be collected = C2	**(1,062)**
Market Coverage C2/P2	**122%**

1.2 Market breakdown among small, medium and manual

- Manual versus Mechanical?

In terms of market size, one third is covered by small operators when two thirds is covered by medium ones, all of them represent around **13,400 trips per year**. The analysis below is based on an average calculation per truck operating not depending on the category it belongs to.

In Phnom Penh, 431 HH/year was considered as an average number of clients per truck. In Siem Reap, in term of market size, the entire market is covered by small operators which represent around 1,100 trips per year. Interestingly in Kampot, 71% of the market is covered by manual operators and 29% by the small operator which represents around 170 trips per year.

- A predominance of “small” private mechanical ETOs

Despite the different contexts, we can see that there is a predominance of private mechanical ETOs on the fecal sludge management market. Manual operators and public trucks are more often used to clean sewers rather than to service households.

There are no large size businesses in Phnom Penh or in Cambodia. Indeed, 69% of the operators have one truck, 23% have two or three trucks and 8% have four trucks. It gives a proportion of 69% of small operators and only 31% of medium size businesses.

However, in Phnom Penh and Siem Reap, an in-depth analysis of the mechanical ETOs shows that the number of trucks is not a determining parameter of the size and type of operators. In each category (small and medium), there are some operators with less than 30 clients per month and other with more than 100 customers each month.

1.3 Business Profile of Operators among *survivors*, *competitors* and *performers*

- Productivity per truck is the key indicators to compare the Mechanical ETOs

The in-depth analysis of the ETOs in the three towns shows that taking into account the number of trucks is not enough to understand the business delivery model. Indeed, there is a wide range of operators. Despite the fact that they have only one truck, some small mechanical ETOs are more dynamic, efficient and profitable than some medium operators. Profit doesn't depend on the number of emptying systems nor on the number of customers in general. It clearly depends on the number of customers per year and per truck, the productivity, but surprisingly, it is not correlated.

Table 10 – Productivity of Mechanical ETOs

	Phnom Penh			Siem Reap		Kampot	
	Small	Medium	Total	Small	Total	Small	Total
<360 clients/y							
Nb of HH/truck	150	48	99	232	232	48	48
Number of truck	2	6	8	3	3	1	1
360-1000/y							
Nb of HH/truck	360	486	444	360	360		
Number of truck	1	4	5	1	1		
>1000/y							
Nb of HH/truck	1 140	1 140	1 140				
Number of trucks	2	8	10				
Total Nb of HH/truck	**588**	**558**	**572**	**264**	**264**	**48**	**48**
Total Number of truck	**5**	**18**	**23**	**4**	**4**	**1**	**1**

Table 4 shows that small operators (less than 150 clients per year or one to three clients per week) are generating higher profit per customer than the ones who have around one client per day (150 to 300 clients per year) because of truck depreciation. Finally, there can be three types of profile:

- Type 1 – small operators **"Survivors"** (from 1 to 150 customers) that make on average 2,400 USD per year profit;
- Type 2 – middle operators **"Competitors"** (from 150 to 350 customers) whose profit can be from less than 1,000 to 1,800 USD per year;
- Type 3 – "big" operators **"Performers"** dealing with more than 350 customers and earning from 4,000 to 20,000 USD per year and per truck profit.

We have hence to be careful analyzing the profile per city between small and medium operators.

- A marginal market for manual ETOs

It is often difficult to compare the cities due to a low number of manual operators in general. In Siem Reap, their absence is also surprising. However, it appears that there are important differences between the manual operator profiles in each city: i) in Phnom Penh, manual operators don't really have this activity as their primary one. They are

used to work in the construction sector and don't consider the emptying activity as a specific one. In Kampot, on the contrary, it seems to be an important activity. We can assume that in small and medium cities, where the market for mechanical emptying is emerging and the rate of those emptying their own pits is important, manual emptiers are quite important to ensure a kind of transition between "self-emptying" and mechanical services.

- No scaling economy

The most important difference between small and medium operators is the depreciation costs for trucks and the high income in return per truck (whose investment has been already returned).

But in general, we can consider that small operators are more dynamic and profitable than medium ones.

There is finally no economy done by scaling the business. Having more trucks increases proportionally the costs and does not generate scale economies as fixed costs constitute an important proportion of the expenses.

- Breakeven point

A simulation of the business plan for those operators shows that the breakeven point is around 19 clients per month in Phnom Penh and 22 clients per month in Siem Reap.

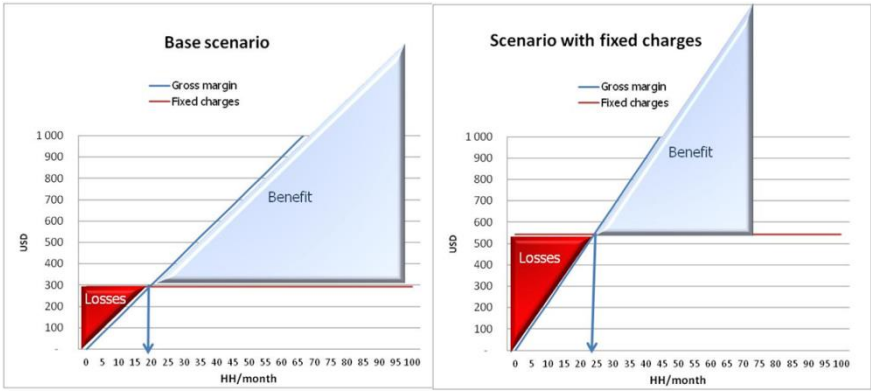
Concerning the investment return, most of the mechanical ETOs have had their investment returned. The average duration of the return is in 2.5 years but some operators could have their investment back in 1.5 years.

- A safe risk mitigation strategy

The high variability of expenses suggests that the ETOs are in a strategy to secure their investment in priority. When they have returned their investment and become stabilized in the market, they can increase their fixed charges to recover more benefits.

We can also notice that this model is highly adapted in terms of equipment and commercial service delivery to the cities and to the demand ($5m^3$ in Phnom Penh, $3m^3$ in Siem Reap). The volume capacity is adapted to service the maximum volume of an HH pit.

Figure 8 – Base scenario and scenario with fixed charges

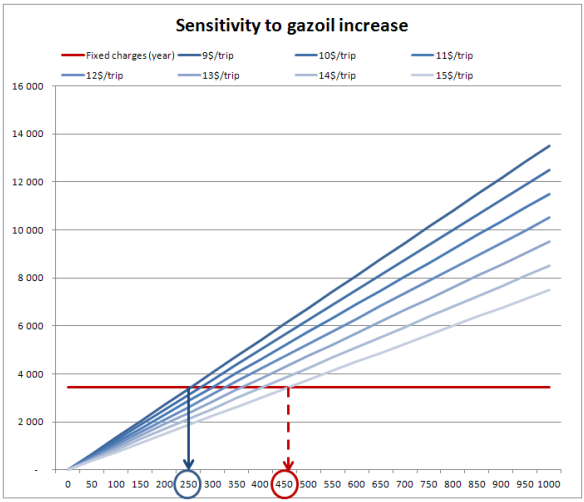


- A high sensitivity to risk of gasoil increase

Transport and energy expenses are high, representing almost 40% of the total. These external factors have an important impact on the business model and explain the differences of fees between each city. The consumption of gasoil is very variable depending on the distance and in each city: in Phnom Penh customers are far from the dumping site and in Siem Reap closer to it.

This appears to be one of the main constraints. The figure below shows a fall of profitability with increasing energy costs. On this point, the business model is very sensitive and an increase of gasoil price has a strong impact on the number of clients needed to be profitable. As example, 1 USD increase per trip raises the breakeven point to 30 customers more per month.

Figure 9 – Sensitivity regarding energy cost increasing



- A low sensitivity to tax increase

Tax costs are the only part which is less variable between cities. It can represent an important expense, especially for small operators (it can be over 18% of the expenses). Moreover, we note that some fines have been delivered this year at unauthorized disposal sites and more controls seem to be done. It represents another risk for the operators (a fine can reach 500 USD). However, the business model is rather less sensitive to this parameter as Figure 10 shows.

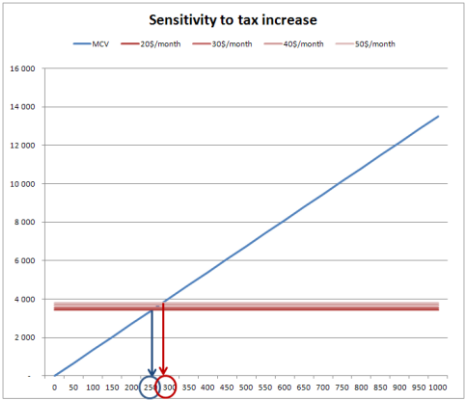
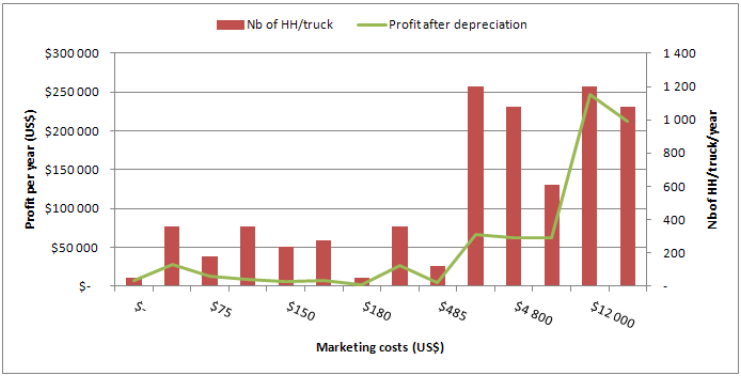


Figure 10 – Sensitivity regarding the tax increasing

- A high importance of marketing costs to be profitable

As we observe in the figure below, the expenses made in marketing are correlated to the profit done and to the number of clients. The success of an operator seems to stand on his ability to do an aggressive marketing strategy by posting leaflets in the city.

Figure 11 – Marketing costs and profit



2. GLOBAL MARKET OVER CAMBODIA

In Kampot and in Siem Reap, the business model appears very sensitive and fragile. The high operating costs compared to their low market (143 HH/year so that 11 clients per month in average is on the limit of profitability) explains that difference.

In general, considering the main criteria of HH/truck, we can see that there is a development dynamic from a certain type of operators and that they are generally interested to continue and develop their businesses; the low amounts of investments are not a check for those operators.

Considering all the specific data for the three cities, we applied a theoretical approach to calculate the market size and the overview of demand and offer across cities. We have taken into account: 1) an average number of persons in HH; 2) an average number of HH per truck operating each year; 3) an average frequency per city; 4) an average volume; 5) the proportion of houses having emptied in each city; 6) the repartition of the market between mechanical and manual ETOs.

Besides, we have considered that in medium cities, despite the fact that we didn't find any manual operator in Siem Reap, the proportion should be the same as in Phnom Penh. Then, we applied those parameters according to the census data to each city.

The results show that there are 81 trucks in all the country, close to the 80 to 90 constructed by the truck manufacturer in Phnom Penh and 74 manual operators in all the country.

Table 11 : Market coverage in Cambodia

CLASSIFICATION OF CITY	NUMBER OF CITY	POPULATION	# trucks	%	# manual	%
Up to 1,000,000 Inhabitants	1	1 242 992	39	48%	24	30%
From 50,000 to 200,000 inhabitants	6	629 963	23	28%	14	17%
From 5,000 to 50,000 inhabitants	35	426 019	19	23%	36	44%
Total	**42**	**2 298 974**	**81**		**74**	

It represents globally: i) a current market of 42,391 HH, 8% of the urban population of Cambodia; ii) almost 320 jobs in the country; iii) 1,271,720 USD per year of incomes (with an average tariff of 30 USD). The potential market represents 38% of the urban population and is located in proportion in medium sized cities rather than in big cities or medium ones.

3. MAIN CONSTRAINTS TO ADDRESS

3.1 Institutional constraints

Even if the national strategies, policies and responsibilities of ministries have limited overlap and are quite clear with legal documents, their application appears controversial and they are often not applied by the government due to a lack of regulatory procedures. Indeed, in most cities, these texts are not locally implemented. The financial and technical means are not allocated to implement those texts (especially on the control side but also on operation and maintenance).

3.2 Commercial constraints: the lack of demand and market competition

- Market competition, lack of demand in a limited market

At this stage, the main constraint that appears clearly is a commercial one: 74% of the operators who say there are problems quote “commercial constraints” as the main one. However, the reasons are not the same, it depends on the city. Clearly, in Siem Reap and Kampot, all the operators are saying that there is a lack of demand. In Phnom Penh city, they said on the one hand that there was a lot of competition (58% of those who responded that it was their main constraint) and, on the other hand that there was a lack of demand (42%). A third constraint is quoted four times: the price negotiation with the HH.

The market seems to increase but is already saturated. No more operators seem to be needed. The offer is too large for the existing market.

- Tariff and demand

Tariffs differ a lot from a city to another. It can be explained by competition but not only. There is an adjustment of fees to cover the charges which are quite similar in each city for the operators in the same range of clients.

However, the tariff cannot be increased too much if new requirement will be needed. The demand and the willingness to pay are limited to 35 US$ per emptying.

Table 12 : Simplified income statements

	Phnom Penh			Siem Reap		Kampot		Total
	Small	Medium	Total	Small	Total	Small	Total	
Average cost of Emptying (HH)	39	33	36	20	20	75	75	42
Income/HH/truck	43	39	41	22	22	75	75	45
Cost/HH/truck	26	32	29	23	23	83	83	43
Profit/HH/Truck	17	7	12	(1)	(1)	(8)	(8)	3

3.3 Technical constraints: very effective and adapted trucks

- Effective technology

Technical constraints were not quoted so much by the E&T operators (20%). The technical problems are related to: pumping (three quotes) and opening the pit cover (one quote); emptying (1 quote).

In the in-depth analysis, the pumpers were saying that there are some houses that are difficult to access where it takes more time to reach the pit. Finally, financial constraints are quoted twice: the energy cost for transportation and the lack of capital to invest, but it appears very specific and not generally shared by all the operators.

The technical analysis of the trucks show that they are very adapted to the Cambodian context and few constraints can be identified.

- But the maximum productivity is not yet reached

In each city (except Kampot), they have adapted the technical equipment to the needs. The average maximum capacity of operators (100HH/truck/month) is not yet reached.

Table 13 : Capacity of trucks

Capacity/year	Phnom Penh		Siem Reap		Kampot	
	# HH	Volume	# HH	Volume	# HH	Volume
Actual Capacity	15 547	69 962	852	2 982	48	120
Potential capacity	37 200	167 400	6 000	21 000	1 200	3 000
Market development potential	42%	42%	14%	14%	4%	4%

3.4 Financial constraints: no constraint… apparently

According to the survey, nobody is interested in loans because, without a clear business plan, they are afraid of taking risks with the bank instead of with their relatives. They are not used to taking loans for this kind of amount.

Due to the low capital cost of trucks and their relatively good efficiency there is not a great barrier to investment.

3.5 Impact on environment and health: downstream of the value-chain

Finally, the main general concern which is less considered by operators is the disposal site and the treatment part of their work. Few sanitation systems are emptied every day but there is fecal sludge produced. They do not reuse the sludge and seem to disapprove the control done by the authorities. None of them has paid any patent or license for desludging. Many different constraints and contextual specificities in each city explain the repartition of the market, the type of assets emptied and the nature of the market (competition or monopoly, structure, tariffs). It must be taken into account for defining a strategy for the country.

Finally, the impact of poor sanitation on public health, living conditions and economic development is little known by the authorities. Moreover, there is a lack of thinking and commitment of treatment infrastructure at local level that can treat wastewater and sludge.

PART. III - RECOMMENDATIONS TO MOVE FORWARD IN FECAL SLUDGE MANAGEMENT

RECOMMENDATION N° 1: IMPLEMENT POLICY DIALOGUE AND SECTOR REGULATION – SUPPORT NATIONAL AUTHORITIES

Key constraints: a lose-lose situation

Even if the national strategies, policies and responsibilities of ministries have limited overlap and are quite clear in legal documents, their application appears controversial and they are often not applied by the government due to a lack of regulatory procedures, particularly in the fecal sludge management sector. An overlap of responsibilities exists among the MPWT and the MoE and urban planning on the regulation of urban sanitation. The situation can highlighted as a lose-lose one. There is no control from the authorities – that allows the easy creation of businesses but with too many business creations the market might turn down.

Key recommendations

Clarify the role and understanding on FSM issues: Responsibilities need to be clarified and reinforced in environmental protection and urban sanitation sectors at the national level. Moreover, information on the reality and the issues of fecal sludge management needs to be disseminated throughout the country.

Create a framework for licensing: There is not clear framework for licensing FSM businesses in Cambodia. A simple authorization can drastically improve the situation. Indeed, a limited number of licenses can be issued related to the number of HH per city and can ensure ETOs that they have a long term view of the market.

Allocate more financial and human means for controlling ETOs: Although fees that are paid at the dumping sites do not represent a high part of business costs, there are no incentives for the operators to go to the dumping sites and on the other side, to control that the operators go there. More human resources and financial means should be dedicated to control these operators.

RECOMMENDATION N°2: PROMOTE DEMAND FOR "PRE-TREATMENT" TECHNOLOGIES

Key conclusions and constraints: bad quality sanitation systems

Most of the fecal sludge is directly discharged into the environment but the pre-treatment paradigm needs to be kept: The current population concentration in towns is a source of a concentration of pollution due to poor sanitation and most fecal sludge in urban areas is directly discharged into the environment without any treatment. The present situation of sewerage and drainage is alarming and requires urgent intervention to address the issues.

Solutions to this problem must be searched within the home "pre-treatment" sanitation family of technologies as "separative" sewerage systems remain far too expensive[3]. Flooding risks are far higher and immediate than risks strictly linked to sanitation in the urban management of the Cambodian cities. It would be unproductive and ineffective to invest twice: i) a drainage system; ii) a sewerage system when the public financing face international funding challenges.

Many private actors build everyday low quality sanitation systems that will compound the problem in the future: Many studies show that the private actors are already delivering most sanitation systems in Cambodia. However, these actors do not know much about technical specifications, as they cannot find technical or financial assistance allowing them to develop the urban sanitation sector. Finally, the quality of systems that they build is low, particularly from the environmental protection point of view. This situation will compound the sanitation problem in the future. Most of the pits built continue to be not sealed at the bottom.

Key recommendations: supporting the supply chain is an investment for the future

The sanitation supply chain actors face: i) a lack of technical and management skills; ii) unavailable friendly sanitation products adapted to the Cambodian context; ii) a lack of access to finance. The sanitation market remains unstructured, making it difficult to bridge supply and demand. To change that, the following recommendations can be identified:

Improve sanitation products: Sanitation supply chain actors have no access to technically standard products. There is a strong need to develop or standardize a large range of environmental products such as: prefabricated latrines and septic tanks, adapted sludge collection and treatment systems.

Improve production processes: Sanitation supply chain actors need to have improved technical processes in order to ensure the environmental and technical quality of sanitation systems and a good management of resource efficiency (less water and cement for latrine production).

[3] The total capital cost of a sewer system is estimated at 1,000 USD per household.

Facilitate access to finance and business management skills: Supply chain actors need to improve their skills in commercial, business planning and financial management. Advocacy aimed at finance institutions needs to be undertaken to allow them to better understand the sector.

There is space for a sanitation business development service center whose aim would be to provide technical and managerial support to sanitation businesses and to help them bridge the gap that exists with the financial sector.

RECOMMENDATION N°3: IN LARGE CITIES AND MEDIUM CITIES PROMOTE DECENTRALIZED TREATMENT SYSTEMS

Key constraints: no market and strong competition

In Phnom Penh, the study shows that there is a great deal of competition. The market seems to increase but is already saturated. No more operators seem to be needed. The first constraint is linked with their unofficial status. The offer is too large for the existing market. Moreover, the analysis of the market shows that presently private ETOs dominate the market.

The market structures show that there are no clear coverage areas that are dedicated to ETOs, that can imply higher cost of energy due to a long transportation. Finally, distance and speed are the highest part of the cost of emptying. The willingness to pay is around 35 USD when private ETOs charge 45 US$. Finally, the two main challenges for mechanical ETOs are: i) promote decentralized treatment system managed by private operators or public utilities in order to reduce transportation costs; ii) decrease the cost of the fees in order to reach more clients.

In medium cities, the market of FSM is more limited than in large cities. The case of Siem Reap shows that no manual operators exist and the market is totally dominated by mechanical operators. The size of truck 3 m^3 is sufficient to have a good level of service. The challenge is related on the number of operators that enter into the market that create an “unprofitable” one.

Key recommendations: Market relocation with small decentralized sludge treatment plants

Promote and develop low-cost sludge treatment plant for ETOs: Currently, there is no real sludge treatment plants implemented. One of the issues is to promote treatment to ETOs showing them they can reduce their transportation costs. The Malaysian solution (ground trench) can be applied as a minimum, more sophisticated technologies could be introduced to produce compost and energy.

Push to reallocate their activities but let the market forces apply: A big challenge is how to control dumping at the official site. To convince them, decentralized system should be developed in order to push them to reallocate their activities. These treatment plants could be managed both by private or public authorities with more regulation from public authorities.

In medium-size cities push to concentration: The only way to reduce the number of ETOs is to push a "forbid new operators" regulation using a licensing procedure or to push current operators to concentration as professional operators. Indeed, because the market is small in medium-cities, FSM remains a secondary activity.

RECOMMENDATION N°4: IN SMALL CITIES, MOVE MANUAL TO SEMI-MECHANIZED TECHNOLOGIES

Key constraints: limited market and competitive manual operators

The case of Kampot shows that the FSM market is very low and does not permit to run a mechanical E&T service like in Phnom Penh or Siem Reap. However, manual operators can play a strong role as they already cover a big part of the market. Moreover, small towns face strong problems on treatment of wastewater and sludge.

Key recommendations: support manual to switch to semi-mechanized

Improve the quality of manual operators: A semi-mechanized "very small truck" consisting of a 2.5 cubic meter tank.

Promote simple sludge treatment technology: With more land, the trench approach developed and tested in Malaysia could be interesting due to the low volume of sludge produced per year.

RECOMMENDATION N°5: PROMOTE PUBLIC AWARENESS AND ENVIRONMENTAL PROTECTION

Key constraints

On the demand side of the sanitation market in Cambodia, access to sanitation in urban areas is quite high but generally the systems used encounter problems and some households are willing to invest in improved sanitation systems. Interestingly, the capacity and willingness to pay for improved sanitation are quite high (50 to 200 USD/household), even though households are not aware of the consequences of poor sanitation on health and the environment and they lack information regarding existing sustainable solutions.

Key recommendations

Inform about sanitation supply chain actors: Providing information on who can build and manage high quality sanitation systems and what are the tariffs charged for each system;

Promote safe urban sanitation: In order to reduce the lack of promotion and advertising to stimulate the demand for sanitation products and services;

Develop access to credit for equipment: Access to micro-credit in order to finance the sanitation systems;

Public awareness: In order to reduce the lack of awareness on environmental and health issues linked to sanitation: public health, living conditions, economic and social impacts.

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Appendix: Comparative general data

Usage of the sanitation facility from survey	Phnom Penh	Siem Reap	Kampot
Household size	4.9	4.9	4.9
average users per toilet	6.3	5.4	5.6
HH Survey Data m: emptying frequency/method			
Emptying Frequency			
% HH that have Emptied at least once	21%	14%	19%
% Never emptied	79%	86%	81%
Frequency:			
Average Frequency of emptying per Year:	0.31	0.56	0.47
More than 2 times per Year	0%	1%	0%
Twice per year	0%	0%	1%
Once per year	1%	2%	3%
Once every 2 years	2%	4%	4%
Once every 3 years	3%	2%	2%
Once every 4 years	3%	2%	4%
Once every 5 years	3%	2%	1%
Between 5 - 10 years	4%	1%	4%
More than 10 years	6%	1%	3%
Method of emptying			
% HH that use manual emptiers	6%	0%	30%
% HH that use mechanical emptiers	80%	86%	30%
% HH that emptied themselves	13%	14%	41%
HH Survey Data : HH expenses			
	Phnom Penh	Siem Reap	Kampot
HH Income/month			
Average income (USD/HH/month)	550	496	530
Cost of other services			
Average water bill (USD/month)	8.03 US$	2.25 US$	6.77 US$
Average phone bill (USD/month)	15.50 US$	12.62 US$	11.36 US$
Average electricity bill (USD/month)	26.67 US$	17.24 US$	14.29 US$
Average solid waste collection bill (USD/month)	Na	Na	Na
Cost of emptying*			
Avg manual emptying Fees per city per service	25 US$		36 US$
Avg. mechanical emptying Fees per household per service	36 US$	20 US$	75 US$
Avg ANNUAL manual emptying cost per household	7.75 US$		17 US$
Avg. ANNUAL mechanical emptying cost per household per service	11 US$	11 US$	35 US$

Mechanical emptying business information			
	Phnom Penh	**Siem Reap**	**Kampot**
# of private mechanical businesses in city	19	6	1
# of trucks run by private businesses	31	8	1
# of trucks owned by utilities	5	1	0
What are utility trucks used for	Private trucks for pit emptying and sewer cleaning of HH; Utility trucks only for main sewer cleaning	Private trucks for pit emptying of HH; Utility trucks only for pit emptying and sewer cleaning	Private trucks for pit emptying and sewer cleaning
# of private businesses that are small (1 truck)	13	5	1
# of pvt businesses that are medium (2-5 trucks)	6	1	0
# of pvt businesses that are large (>5 trucks)	0	0	0
What are the capacities of private trucks (m^3)	5	3	5
What are capacities of Utility trucks (m^3)	7	7	0
Price for new truck (mention for what m^3 capacity)	20,000 US$	15,000 US$	20,000 US$
Price for USED truck (mention for what m^3 capacity)	15,000 US$	12,000 US$	15,000 US$
Are most trucks 2nd hand or new at time of purchase	Yes	Yes	Yes
Typical age of trucks in city?	8 years	8 years	8 years
What is typical number of trips per day for the trucks?	1.6	0.6	0.1
Avg distance per trip	15 km	5 km	15 Km
Avg time per trip (hr)	2 hours	1.5 hours	2 Hours
Cost of fuel for truck? (USD/liter)	1.4	1.4	1.4
Financial access for private owners			
What % of the private truck owners take loans?		17%	
What are bank interest rate and years for repayment?		18% and 3 years	
Are the rest self-financing?		Yes	
Do they run any other business from which they get this self finance money?		Yes	
What % of the FS emptying owners does this as their main busines	79%	40%	
What are the other sources of funding for these operators besides bank and personal money?	personal fund and family	personal fund and family	personal fund and family
Treatment/dumping site			
	Phnom Penh	**Siem Reap**	**Kampot**
What is the official dumping site for city?	wetlands	WWTP	Nothing
What is the m^3 capacity of this treatment facility? Max flow/day dur	1,000,000	Na	-
Where is it located?	edge of city	outside city	-
What is the dumping fee truckers have to pay? (USD)	1.5	1.5	-
Is this payment per trip or per month or m^3?	per trip	per trip	-

BILL & MELINDA GATES foundation

WORKING PAPER

LANDSCAPE ANALYSIS & BUSINESS MODEL ASSESSMENT

Fecal Sludge Management in Cambodia

OVERVIEW AND KEY FINDINGS

The “Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Cambodia” aims to gather and rigorously analyze data based on a representative range of criteria to better understand fecal sludge management in Cambodia and especially its extraction & transportation. It aims to better understand the living conditions of these operators, their technical, financial and economic situation, and the market size through a household survey. At a secondary level, it aims to provide key data and recommendations about the opportunities, constraints, conditions and potentiality of development of these markets in a prospective analysis.

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