DOMESTIC PRIVATE FAECAL SLUDGE EMPTYING SERVICES IN CAMBODIA: BETWEEN MARKET EFFICIENCY AND REGULATION NEEDS FOR SUSTAINABLE MANAGEMENT[1]

Clément Frenoux[1] and Alicia Tsitsikalis[2]

[1] LEREPS/GRET, Université de Toulouse 1 Capitole, Manufacture des tabacs, 21 allée de Brienne, 31 042, Toulouse, email: clement.frenoux@ut-capitole.fr, frenoux@gret.org
[2] GRET, Campus du Jardin Tropical, 45 bis avenue de la Belle Gabrielle, 94 736 Nogent sur Marnes cedex, email: tsitsikalis@gret.org

ABSTRACT

Over the last two decades, Cambodia has experienced rapid economic and urban growth but still faces numerous challenges, one of them being urban sanitation. While access to improved sanitation reached 29% of the total population in 2008, there remains a gap between rural areas, where access is low, and urban areas, where access is high (80%). However, this situation masks the reality and the issues of urban sanitation in Cambodia. Indeed, most of the sanitation systems are characterized by on-site technologies, in urban areas, where Faecal Sludge Management (FSM) services are commonly ignored and unknown. Very few studies have been undertaken and this paper aims to partially fill the gap by presenting key results, findings and to demonstrate that beside affordable sanitation technologies, profitable private businesses and services, efficient market based approach; the current Cambodian urban sanitation situation produces strong negative environmental externalities that do not create a sustainable urban sanitation management system. Based on a large field study on supply and demand of FSM services conducted in three cities in 2011: Kampot (a small city), Siem Reap (a medium-sized city) and Phnom Penh (the capital), this study aimed to assess the viability and efficiency of current urban FSM services. Field study results confirmed that access to sanitation in urban areas of Cambodia is high but strongly heterogeneous. Following an unrecognized status and unclear policy, the market of FSM services is dominated by small domestic mechanical private Extraction and Transportation Operator, characterized by high competition and market based approach. Most of them are profitable and efficient, provide at a cheap tariff among 20 USD to 50 USD with good quality FSM services, thanks to an adapted business model based on low market entry costs (12,000 USD for a locally assembled truck) and low operation and maintenance costs. Consequently, the Cambodian urban sanitation paradigm looks economically efficient among low costs entry, cheap costs to access to sanitation; reasonable faecal sludge services fees; high service quality and profitable businesses. However, at the upstream of the sanitation value-chain, low quality sanitation technologies are predominant (pits are rarely watertight) and most of FS are directly discharged into the environment at the household stage. Consequently, the proportion of households having emptied their faeces tank is also really low, on average 20% of the total urban population, even though tariffs are cheap. Furthermore, most of the faecal sludge collected by domestic private operators is directly discharged into the environment. This is due to high transportation costs to reach few or inexistent treatment plants. This situation raises the issue of

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public control and regulation both on household practices and private operators over this competitive and relatively efficient market. This paper also highlights the difficulties to regulate this kind of service, the importance of adapted institutional arrangements, following cities characteristics (size of market, treatment and transport technologies).

Key words: FAECAL SLUDGE MANAGEMENT, PRIVATE OPERATORS, URBAN SANITATION, MARKET EFFICIENCY, REGULATION

INTRODUCTION[2]

Over the last two decades, Cambodia has experienced a rapid development but still faces numerous challenges, one of them being urban sanitation. The current situation of sanitation access remains unclear as the Economic Impacts of Sanitation study (Kov P. 2008): coverage rates for instance vary from 56.1% to 61.1 % following the data available. There are large gaps between rural areas, where access to improved sanitation is low, and urban areas, where access to sanitation is higher (80%). However, if many international stakeholders have paid attention to the growth rate of access to sanitation, few organizations have either offered a comprehensive analysis or worked on the faecal sludge extraction and transportation in Cambodia.

This paper aims to partially fill this gap by presenting key results and findings of a large field study[3] on supply and demand of FSM services conducted in three cities in 2011: Kampot (a small city), Siem Reap (a medium-sized city) and Phnom Penh (the capital). It aimed to assess the viability and efficiency of current urban FSM services. This paper aims particularly to: discuss the advantages and the performance of a market approach to urban sanitation management ; demonstrate that beside affordable sanitation technologies, profitable private FSM businesses exist; show that the current Cambodian urban sanitation situation produces strong negative environmental externalities and thus that a market approach does not create alone a sustainable urban sanitation management system. Field study results confirmed that access to sanitation in urban areas of Cambodia is high but strongly heterogeneous. Indeed, most of 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 to sewerage systems composed of unstructured sewers and open canals. For households (HH) located outside the service coverage area, on-site systems are most common. Because of unclear policy and lack of recognized status, the market for FSM is dominated by small domestic private mechanical Extraction and Transportation Operators (ETOs), characterized by high competition on an open market. Most of them are profitable and efficient, provide at a cheap tariff (ranging from 20 USD to 50 USD) a good quality FSM services, thanks to an adapted business model based on small market entry costs (12,000 USD for a locally assembled truck) and low operation and maintenance costs. Consequently, the Cambodian urban sanitation paradigm looks economically efficient among low costs entry, cheap costs to access to sanitation; reasonable faecal sludge services fees; high service quality and profitable businesses.

However, upstream of the sanitation value-chain, low quality sanitation technologies are predominant (pits are rarely watertight) and most FS is directly discharged into the environment (also due to lack of control of public administration when the pit are full) at the household stage. Consequently, the proportion of households having emptied their faeces tank is low, on average 20% of the total urban population, even though tariffs are cheap. Thus, faecal sludge management coverage is low and problematic, causing environmental and public health threats. Furthermore, most of the faecal sludge collected by domestic private operators is directly discharged into the environment. This is due to high transportation costs to reach few or inexistent treatment plants. This situation raises the issue of public control and regulation both on household practices and private operators over this competitive and relatively efficient market. This paper also highlights the difficulties to regulate this kind of service, the importance of adapted

[3] This large study was funded by the Bill and Melinda Gates Foundation.

institutional arrangements, following cities characteristics (size of market, treatment and transport technologies).

METHODS

The results presented in this paper come from a large study conducted in Cambodia from June to November 2011 aimed at gathering and rigorously analyzing data based on a representative range of criteria to better understand faecal sludge management in Cambodia and especially its extraction & transportation.

The first challenge was to identify and select a range of cities, representative of cities in Cambodia. Excluding Phnom Penh with its 1.24 million of inhabitants, urban areas can be divided into small and medium 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. In order to select the three cities surveyed that are representative 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 (1.24 Million inhabitants), Siem Reap as a medium one (168 700 inhabitants) and Kampot as a small city (38 800 inhabitants).

Household demand and satisfaction survey

The household survey sampling was based on the number of population and a transect approach in each city. Data was collected from June to September 2011. A total sample of 1,320 households for Phnom Penh, 426 households for Siem Reap and 303 households for Kampot were surveyed using a closed question questionnaire. The transect approach was considered as the most appropriate in the specific case of Cambodian cities due to the strong geographical heterogeneity and high socio-economical homogeneity of these cities and its impact on sanitation practices (Esaie 2010). The number of HH surveys to be conducted was based on the population density in each commune (with the same surface area on average) along transect. Different criteria were tested to identify the demand determinants: type of equipment, socio-economic status, and specific location on the city.

Table 1 – Survey Distribution per cities (MoP 2008)

Name of the city	Number of population	Number of HH	HH in transect selected	Number of survey	% per transec
Phnom Penh	1,242,992	243,724	65,974	1,320	**2.00%**
Siem Reap	168,662	33,071	10,768	426	**3.96%**
Kampot	38,819	7,612	5,137	303	**5.90%**

Extraction & Transportation Operators and supply-chain survey

The analysis of ETOs combined two steps: i) a pre-screen survey to identify all the operators in each cities (that were unknown): 26 private mechanical operators and 25 manual ones (24 in Phnom Penh, 1 in Kampot and none in Siem Reap) were surveyed by phone screening; ii) a total of 22 operators were interviewed in detail, as were relevant stakeholders along the supply-chain (constructors, institutional actors) as secondary data were reviewed. Technical field visits were done to collect data on the dumping sites. The following typology of operators were used: i) public ETOs; ii) private ETOs: small (only one truck), medium (from 2 to 4 trucks) or large (more than 4 truck); iii) manual ETOs. Following the data gained directly from the ETOs Gret conducted cross-check analysis in order to confirm or refute some data such as: price of fuel, taxes paid at the dumping site (we conducted two analysis to check the real number of trucks that dump at the official site and finally only 5 out of 31 do so), real investment cost from the truck maker, fees charged from the HH survey. The financial analysis is also based on a cross-check between the data given by the operators and hypothetic calculation.

Table 2 – Survey Distribution of ETO survey per city

Type of ETO	Name of the city	Category	Estimated total number of ETO	Number of ETO surveyed	%
Manual ETO	Phnom Penh		24	5	21%
	Kampot		1	1	100%
Mechanical ETO	Phnom Penh	Small	12	5	42%
		Medium	4	6	86%
	Siem Reap	Small	5	4	80%
		Medium	1	0	0%
	Kampot	Small	1	1	100%

Data analysis method

The market and sludge production estimates analysis was based on a cross-check of these different steps of analysis and refers to data collected. The issue was to articulate data given related to i) the frequency of emptying services, ii) the volume of faecal sludge produced per type of system , iii) the nature of equipment (septic tank, pits,…), iv) the location of the discharge. The main bias is in the nature of the study whose ambition was to be prospective without having historic trends on demand. To estimate future demand, according to our survey, the following hypotheses were 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.

RESULTS: THE QUITE HIGH MARKET EFFICIENCY OF CAMBODIAN FAECAL SLUDGE MANAGEMENT

Typology of urban sanitation technical option: flood control, wastewater collection and high access to sanitation

Following the Cambodia Demographic and Health Survey (NIS, 2005), Phnom Penh has a high rate of HH connected to the sewer when the medium-sized and small cities like Siem Reap and Kampot used more septic tank and other on-site sanitation systems.

Table 3 – Sanitation coverage by region (urban area) (NIS 2005)

	Improved sanitation (%)				Unimproved sanitation (%)				
	Sewer connection	Septic Tank	Pit latrine	Total	Public toilet	Pit latrine	Open	Other	Total
Phnom Penh	90%	3.9%	0.6%	94.4%	-	0%	2.8%	2.8%	5.6%
Siem Reap*	5.5%	43.1%	3.1%	51.7%	-	0.2%	43%	4.9%	48.1%
Kampot**	7.7%	33.3%	0.8%	41.8%	-	1.2%	49.7 %	7.3%	58.2%

*based on the Tonle Sap region average data and not on Siem Reap specific, **based on the Coastal region average data and not on Kampot specific.

However, behind these standardized data there is a large range of technological options that are commonly used in Cambodia (Roberts 2007a; 2007b). Indeed, there is currently no technical standard for urban or rural sanitation and rural technologies are often used in an urban context. However, some "standard designs" can be identified: i) multi-storey buildings which are connected directly to combined sewerage systems[4] or to septic tanks (on-site); ii) middle standard households which sometimes use "septic tanks"

[4] The sewerage systems installed in Cambodia are combined systems that collect both wastewater and rainwater. They are often composed of: i) a secondary sewer system; ii) a primary open-channel system; iii) pumping stations; iii) wetlands that treat the effluent.

but more often interconnected pit systems either discharging directly into combined sewerage systems or infiltrating; iii) urban poor or other HH which have no sewage system and use traditional pour-flush latrines with pits. Based on this description, 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). This is due to the specificity of the Cambodian urban sanitation paradigm that aims 1) first at flood control, using in part open air drainage systems and then 2) to collect wastewater. Consequently, existing sanitation collection and treatment systems follow this paradigm and combined sewer work as a drainage system and more at a settled sewer, the sludge is normally intercepted by pits or tanks and in most cases there is a pretreatment stage before discharging wastewater into the sewer or the environment.

Based on the three cities case study, the high urban sanitation coverage is confirmed with 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 large variety of sludge pre-treatment facilities (pits, tanks, septic tanks, etc.). Considering only the pre-treatment facilities, most of systems are constituted by infiltration pits (like in rural areas). In Phnom Penh, almost 26% of HH have no pre-treatment facilities and are connected to the sewer directly (24%) whereas in Siem Reap or in Kampot, every HH has pre-treatment assets on their land, most probably linked with the higher density of Phnom Penh city. The living conditions in the three towns presents similarities (number of people per household) and differences (smaller housing and more of it in shared buildings in Phnom Penh, lower proportion of well-off households in small and medium towns).

Unclear or inexistent institutional and legal framework regarding Faecal Sludge Management

In Cambodia, several ministries are involved in urban sanitation management but four ministries are predominant: i) the Ministry of Public Works and Transport (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; iii) the Ministry of Land Management and Urban Planning (MoLMUP) is responsible for construction standard control and issuing construction permits; iv) the Ministry of Rural Development (MRD) is responsible for rural sanitation (latrine construction and standards). At the provincial level, a local department of each ministry exists and is involved with the provincial authorities in urban sanitation management.

In 2003, the Cambodian government issued the National Policy on Water Supply and Sanitation, a “key crucial factor for setting up an institution that can maintain and expand the services”. It is the only document that frames urban 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” (RGC 2003). However, guidelines do not consider non-sewer solutions (that often exits in urban areas), and only look for financing mechanisms, including “target subsidies in exceptional circumstances” (Kopitopoulos 2005).

There is no mention of FSM control and regulation in any document reviewed. Finally, FSM is currently controlled only by the MPWT through the delivery of licenses for vehicle circulation and by the MoE that delivers licenses for discharging or effluent transportation when the amount of their effluent exceeds ten cubic meters per day not including the amount of water used to cool the engine and control dumping site in each cities when they exists.

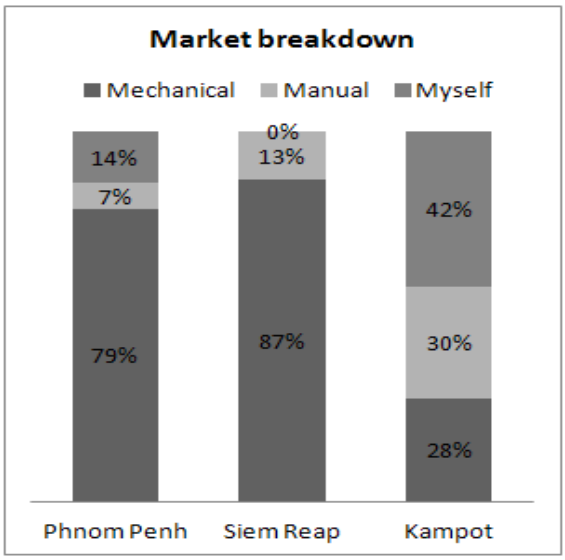
Household Faecal Sludge Management is dominated by Small mechanical private ETOs

When the pits or septic tanks are full, the household has few possibilities to disludge. The Public Administration has pit empting trucks (Phnom Penh and Siem Reap have respectively 10 trucks and 1 truck) but they are dedicated to operate and maintain the primary sanitation systems of the cities. They do not disludge at the household level. The lack of service is filled by small private “informal” operators who have been investing in the sector for the past 20 years without any incentives from the government. Following

study results, these private ETOs appear to be the main pit emptying service providers for households and small businesses.

Private mechanical ETOs dominate the market (excepted small-cities like Kampot). In Phnom Penh, the current market is covered at 74% by mechanical private ETOs, at 14% by HH themselves and 7% by manual operators. The current market in medium-sized cities, Siem Reap, is over-dominated by private ETOs at 87%. Few HH empty their sanitation system themselves (14%). In Kampot, or other small cities, the manual operators have a larger part in contributing to faecal sludge management services.

Figure 1 – Faecal Sludge Management Market Structure



Mechanical private ETOs can be characterized as family-scale companies with one to four trucks insuring a service for HH and a few businesses. They are mostly small-sized enterprises owning only one truck with two to three staff. There are no large size businesses (more than 4 trucks) in Cambodia. In Phnom Penh, 69% of the operators own only one truck, 23% have two or three trucks and only 8% have four trucks. It gives a proportion of 69% of small operators and only 31% medium size businesses. All of them represent around 13,400 trips per year. In Siem Reap, 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 only 170 trips per year.

<u>Low entry costs and technical innovation</u>

The specificity of ET business model is that there are low entry costs because of second hand locally assembled trucks. The upfront investment is finally very low. According to one Cambodian 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$. The total end cost depends on the quality of the truck. The advantage of locally assembled trucks is: the maintenance can be done locally, the tank size can be chosen, and the tank can be changed without changing the engine. Interestingly, the tanks have different sizes depending on the city: from 3 m^3 in Siem Reap, 5 m^3 to 8 m^3 in Phnom Penh and Kampot. The smaller trucks are cheaper on average, their cost varies from 12,000 US$ to 15,000 US$ also depending on the quality of the truck. The trucks appear technically and economically adapted to the site of work in order to gain efficiency. One of the most crucial arguments for the service quality stands on the capacity of the truck to empty all the sanitation systems (pits). Therefore, many mechanical private ETOs consider that they need a big truck in Phnom Penh because the demand is high and the distances bigger. None of the operators in Phnom Penh said that he had exceptional volumes or had to do 2 trips for a single HH. They also never have mixed sludge from 2 different HH in the same trip.

<u>Aggressive commercial-oriented approaches</u>

Technically adapted, their service delivery model also seems commercially adapted. The fees are globally competitive and cheap. In Phnom Penh, for example, it represents less than 0,2% of the annual household

expenses (0,35% for the poor, and 0,12% for the well-off households). In Phnom Penh, The fees appear quite homogeneous for mechanical private ETOs and the average tariff is estimated at 36 US$/trip that is quite low[5]. In Siem Reap, the average fees are about 20 US$ on average but can be close to 150 US$ as a maximum. The tariff is lower than in Phnom Penh, due to the lower distance from emptying location to the dumping site (5 km). In Kampot, due to the low number of clients, the mechanical ETO is constrained to have a high tariff to cover his expenses about 50 US$ per 2 rings (2 m^3) in Kampot (25 US$ per ring) with an extra charge of 30 US$ for Kep. The manual operator has a tariff depending on the size of the work and on the number of rings. It is around 12 US$ per ring emptied.

According the household survey, service satisfaction is very high ranging from 96% in Phnom Penh to 98% in Siem Reap. For mechanical services, the reasons of satisfaction are that the service is clean (fist quotation), the operator is quick to come (second quotation) and fast to operate (third quotation). Concerning the manual pumper, the satisfaction comes from the clean service and the cheaper tariff. As a consequence, the dissatisfaction for mechanical ETOs comes from the tariff considered too expensive and for the manual ETO, from the service considered too long. Despite the fact that households are satisfied, 58% of the households who emptied won't call the same operator the next time. It seems that there is no "fidelity" in this sector and every service given is on a competitive way for one time only. As in Phnom Penh, in Siem Reap, the ratio of faithful clients, those who will call the same operator for a future emptying is very low close to 24%.

Consequently, the Mechanical private ETOs have developed an aggressive and adapted commercial-oriented approach. About 180 leaflets per client per truck are disseminated throughout Phnom Penh, telephone numbers are painted on poles and sign boards. . Following study results, almost 7.4 million of leaflets were distributed in Phnom Penh for 31 trucks, which represent about 15 leaflets per client. Except for 2 operators, there is at least 2 marketing staff that is normally permanent confirming the commercial-oriented strategy of these structures.

<u>Profitable and sustainable business</u>

The mechanical ETO activity is characterized by high operational costs (gasoline and human resources are the main ones). Transport and operation costs represent from 47% (Phnom Penh) to 66% (Siem Reap) of the total costs. The analysis shows that the average cost per trip can vary a lot among the ETOs. Some of them are very productive with a cost around 18 US$ when others are less productive with an average cost per trip of 33.9 US$. Only one was unprofitable. Not surprisingly, the gasoil consumption is largely variable depending on the distance and in each city: in Phnom Penh customers are far from the dumping site and in Siem Reap closer to it. On this point, the business model is very sensitive and an increase of gasoil price has a strong impact on the number of clients needed to be profitable. As example, a 1 US$ increase per trip requires the operator to have 30 customers more per month to remain profitable.

For operation, there are on average 3 staff per truck: one is responsible for work evaluation, driving the truck and/or price negotiation; other two do the emptying work. 56% of the operators give a variable part from 20% to 25% of tariff as wage. Concerning the investment return, most of the mechanical ETOs have had their investment quickly 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 projection 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. The most important difference between small and medium size operators is the depreciation costs for trucks and the high income in return per truck (whose investment has been already returned). Having more trucks increases proportionally the costs and does not generate scale economies.

[5] However, all ETOs surveyed said that the tariff of emptying service has a variable structure depending on the volume to be emptied and the distance of the trip. It can varies from 30 to 50 USD for a trip, not far from the Manual ETOs that have a tariff fee varying from 25 US$ to 30US$ (but the household said that they pay more in general 45 US$).

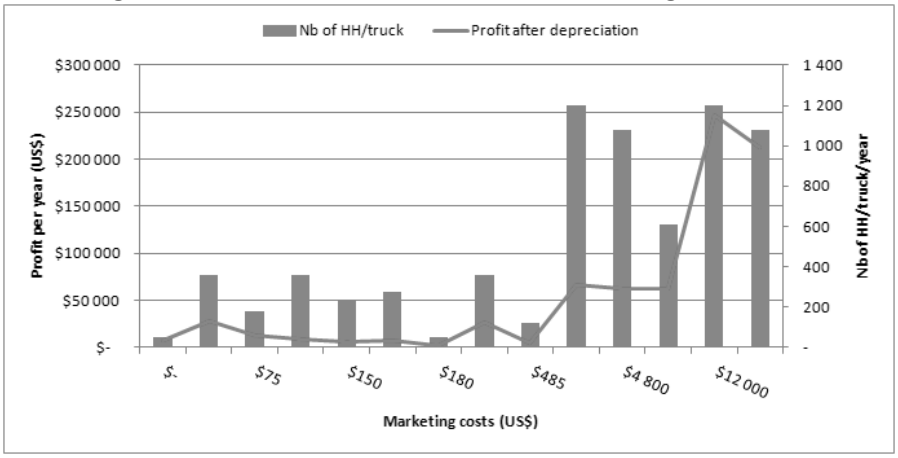
Efficiency gains: Dynamism and innovative behaviors

In Phnom Penh, on average, there are 431 customers per year per truck so to say 36 HH/month. However, there is a wide range of differences among the ETOs from 48 HH per year per truck to 1,212 HH per year per truck. In Siem Reap, in average there are 264 customers served per year per truck (22 HH/month in average). The business structure is more homogeneous than Phnom Penh ranging from 156 to 276 HH/year. In Kampot, due to the different structure of the market, the only mechanical ETO that appeared recently has on average 48 customers per year (4 HH/month in average). Mechanical private ETOs presents a high diversity of profile and results, some of them are more dynamic, efficient and profitable. Their performances are mainly based on their productivity, measured by the number of clients per truck per year, which can vary a lot:

- Type 1 - "Survivors" (from 1 to 150 customers per year) that 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 like the case 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 type 3 includes the most dynamic operators and may be the only ones who will survive from this competitive market in the long term. Indeed, the expenses done in marketing are strongly 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 2 – Direct correlation between Marketing and Profit



A strong competition exists that leads to an efficient and profitable business model. Demand is satisfied with this service that is at a quite affordable tariff. Financial constraints for investment do not appear as a major constraint due to low market entry costs. Technical constraints are also not felt as a problem as locally assembled truck allow easy maintenance and access to spare parts whenever they are needed. The main constraints applying to operators seems to be business ones due to an important competition over operators and a rather low demand in Cambodian cities.

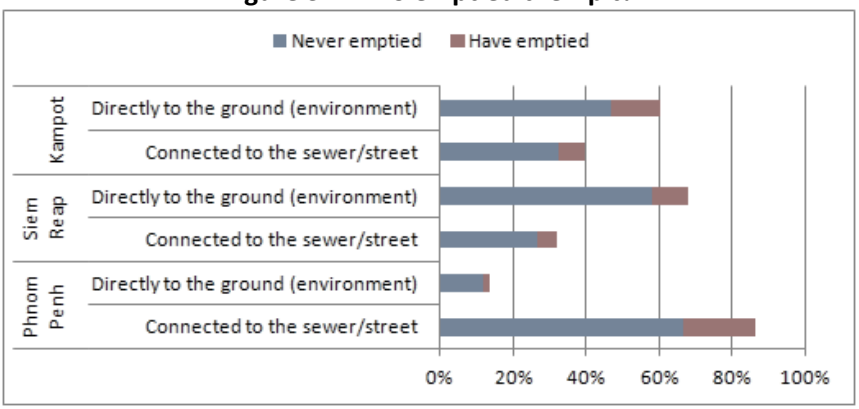
DISCUSSION: SUSTAINABLE SANITATION MANAGEMENT, THE PROBLEMS OF NEGATIVE EXTERNALITIES AND THE TWO UN-REGULATIONS ON HOUSEHOLD AND MECHANICAL PRIVATE ETOS

Low demand, uncontrolled, unsuitable technologies and strong discharging at the household level

The proportion of households in the total sample having emptied their faeces tank is really low in each city only: 21,9% in Phnom Penh, 14% in Siem Reap and 19% in Kampot. Low demand is a strong specificity of

the Cambodian faecal sludge management sector. The frequency of emptying is also quite low. On average, in Phnom Penh, the frequency is 0.31 emptying per year (the assets are emptied every 3 years), which is quite similar to 0.25 (median) of the sample (once every 4 years). In Siem Reap, it's closer to 0,56 (once every two years). The average volume is also quite different per type of treatment assets. There is no real correlation between the date of construction, the volume of tank, the water consumption, and if the HH is connected to the sewer or not. The demand is also not correlated to the socio-economic profile. Poor households have almost the same desludging practices and the same nature of facilities. For example, 17% of them who have emptied did it manually themselves when they are 18% of the medium ones.

Figure 3 – Who emptied their pit?



Another surprising fact is that most of the HH surveyed that emptied their latrine are connected to the sewer (20% when 1.9% is not connected to the sewer). Indeed, due to the pre-treatment stage before discharging to the sewer most sanitation systems in Cambodia need to be emptied. 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. In Phnom Penh, the centre of the city is more represented due to certainly the date of installation. Possibly flooding in the city has also an impact most of empting is done during the rainy season (74%).

One of reasons to explain the low frequency can be related to the number of people which are living in the house. In average, there are 6 people in the houses that never emptied their pit or septic tank whilst there are 8.4 persons in the houses that have emptied. However, one can find that upstream of the sanitation value-chain, low quality sanitation technologies are predominant (pits are rarely watertight) and that no control when the pit are full are done. Consequently, most of FS is directly discharged into the environment at the household level that could have a strong impact on public health and environment in the future. Indeed, a theoretical approach based on the average volume of production of sludge estimated at 0.06 m^3/pers/year (0,17 l/capita/day) was used to calculate the theoretical production of the city. It appears that 92,941 m^3 of sludge is produced in Phnom Penh, 25,662 m^3 in Siem reap and 489 m^3 in Kampot. However, 29% of the sludge produced in Phnom Penh is actually collected through operators, only 9% are in Siem Reap and 53% in Kampot.

<u>Saturated market and direct discharging of mechanical ETO</u>

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. 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. 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 income (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 small ones. Estimating the actual capacity of pumping and the number of trucks, we can see that the market coverage is very high, 77% in Phnom Penh,

57% in Siem Reap, 122% in Kampot. Due to a low demand, the actual capacity of the market to absorb future demand appears very high.

In Phnom Penh, Private ETOs pay 1.5 USD/dumping/trip and must theoretically discharge into official dumping site far from the centre. However, 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 faecal sludge at a 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 of ETOs said that they dump at the dumping site, the survey shows that only one really goes there. Finally, only 16% of the operators are discharging in the authorized sites (5 trucks over the 31 in Phnom Penh). So, many unofficial dumping sites exist throughout the city mainly due to the cost of transportation.

In conclusion, most of the faecal sludge produced is directly discharged into the environment through the infiltration pits and are not collected neither through the sewer or the open channels, neither by the operators. This situation has a strong impact on health and hygiene and raises an important issue that is even more important due to the urbanization growth and entirely justify the role and the intervention of both national and local authorities. It raises the fact that solutions have to be implemented regarding the actual market and the trends observed in each city. A model can't be applied regarding the extreme diversity of the situations.

Based on this overview of faecal sludge management, five main recommendations are proposed in order to improve, optimize services quality, efficiency and effectiveness on Faecal Sludge Management sector in Cambodia:

1) 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 the specific faecal sludge management sector there remains overlapping responsibilities among the MPWT, the MoE and urban planning on the licensing process and on control and regulation of faecal sludge activities. This fact seems to have negative impacts on sector development. Land regulation and MIME could promote pre-treatment technologies at the household scale. Standards of construction and on evacuation should be then controlled at the local level. MoE and MPWT should work closely during the licensing process of the operators. Actually, the MPWT deliver licensees for the trucks without controlling their use. In addition, control means human and financial means dedicated to this activity. All of these recommendations could be enforced within a strategic framework that takes into account a value chain approach, not ignoring the interrelations between each issue in sanitation urban sector.

2) Increase demand, control 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 no control from public administration of direct discharging. Consequently, most of faecal sludge in urban areas is directly discharged to the environment without any treatment. Flooding risks also is the most important problems 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 discharged in the drainage system and faecal sludge collected by the ETOs.

3) In large and medium cities, develop decentralized sludge treatment systems but let the market forces influence the behaviours: 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 FSM tariff. It seems important to let the market forces act. A strict zoning approach within PPP contracts is not adapted to the Cambodian cities

and to the existent market developed. However, investing in decentralized faecal sludge treatment plant can push operators to reallocate their trucks in strategic places and could help optimizing the transportation costs and reducing at the end the final cost for the customers protecting the environment at the same time.

4) In small cities, 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 faecal sludge. Finally, burying sludge, a practice adopted since a long time in Malaysia, could be an efficient solution for small cities and should be developed to avoid any future problem in the town. They also could be encouraged and subsidized to get semi-mechanized systems that can allow them to transport the sludge in bigger distances than what they actually do.

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.

CONCLUSIONS

It's commonly accepted and criticized that 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). Does-it means that nobody is acting in this field? On the contrary, this study demonstrates that the market for extraction and transportation operators is almost saturated due to a great deal of competition and a limited demand. In fact, private mechanical operators dominate the market for households and small producers when public operators are offering sewerage cleaning services. Besides, even if the operators are small, having one to three trucks, their business model are quite profitable. They offer an affordable tariff and a satisfactory emptying service. They have adapted their offer technically and commercially due to a risk mitigation strategy and low entry costs. The Cambodian faecal sludge market looks economically efficient with reasonable fees, high service quality and profitable businesses. However, this market produces strong negative environmental externalities that are not included in the tariff. Indeed, most of the faecal sludge is directly discharged both by households and private operators into the environment. This situation raises the issue of public control and regulation over this competitive and relatively efficient market. Besides, this paper highlights difficulties to regulate this specific service, the importance of adapted institutional arrangements, following cities characteristics (size of market, treatment and transport technologies) and proves that an integrated value-chain approach is the key method to assess the sector. However, in larger view, the conclusion opens the questions on who will finance the needed treatment facilities (public or private) and who will support the costs (household) through what financial mechanisms (direct or indirect)).

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