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37th WEDC International Conference, Hanoi, Vietnam, 2014**SUSTAINABLE WATER AND SANITATION SERVICES
FOR ALL IN A FAST CHANGING WORLD****How cheap can hygienic latrines be?***Do Hong Anh, Nguyen Viet Anh, Le Trong Bang & Pham Doan Thanh Binh, Vietnam***BRIEFING PAPER 1981**

A construction and operation costing of 12 types of hygienic latrines widely used in rural areas of Vietnam and presented in the Hygienic latrine Manual of the Ministry of Health, using traditional construction materials has been conducted. The cost of latrines using traditional construction materials is ranging from USD37.5 (VIP) to USD194.4 (Septic tank constructed by brick for treatment of black and grey wastewater from sitting bowl toilet). Annually averted O&M costs of Vietnamese latrines range from USD1.86 (VIP) to USD 4.58 (wet latrine with septic tank) per capita per year. Costs of hygienic latrines can be further reduced, applying solutions such as using local materials for construction, reducing the tank volume by using the water-saving flushing devices or applying more frequent tank emptying services and mass production of latrine components. The less a hygienic latrine costs, the more chance for poor people in different places can get access to improved sanitation.

Background

Clean water and sanitation are basic human needs in everyday life, and are becoming more urgent requirements for health protection and for improvement of living conditions of people. In Vietnam, the rural population accounts for 68% of total population. Agriculture has always occupied an important role in the national economy. However, the rural population is generally poor, and in the process of economic reform increasingly lags behind urban residents in terms of both economic development and quality of life. The National Strategy on Rural Water Supply and Sanitation has set the objectives to provide 100% of rural populations with clean water, with a minimum demand of 60 liters per person per day, and with access to hygienic latrines. By the end of 2013, about 80% of the rural population were being served with clean water of different means (tapped water, dug well, rain water, etc.), and about 60% of households were equipped with hygienic latrines (MOH, 2014). However, systematic surveys have shown a much lower percentage of hygienic latrines meeting the criteria set by the Circular 27/2011 of the Ministry of Health or MOH (WB, 2013).

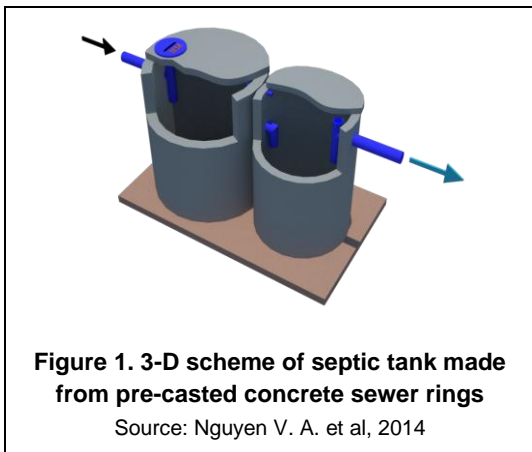
The reuse of human and animal excreta is a long-standing practice of Southeast Asian countries including Vietnam. This contributes nutrients to the soil, improves crop yields and is economically beneficial for households due to reduced chemical fertilizer requirements. The reuse of excreta, especially untreated excreta, however, brings potential risks to human health such as diarrhea, intestinal parasitic infections and nutritional deficiencies in children.

The WHO guides that human waste should be stored for 1-2 years before it can be re-used (WHO, 2006). The MOH of Vietnam requires minimum storage of human waste for 6 months in the pit with lime or ash added after each time of use (MOH, 2011). In practice, farmers in many rural areas have two rice crops and one other crop like vegetables per year. Because of fertilizer needs and limited awareness, the excreta are usually taken out from the storage earlier than the time required above. A survey of the research team from the Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering and the London School of Hygiene & Tropical Medicine (LSHTM) in some rural areas of the Red River Delta, Vietnam showed that 68% of households store excreta for less than 6 months, and 35% of households use excreta as fertilizer directly (Gulliver, F. R. Z. et al., 2013). Additionally when the crop requires, the whole pit is often emptied, waste is taken out and packed in bags for 2 to 4 weeks, before it is applied to the fields.

Provision of information of public health protection and selection of hygienic latrines to the people especially in rural areas is a very important task in Community-Led Total Sanitation (CLTS) and other

sanitation promotion campaigns. Hygienic or sanitary latrines should ensure collection and isolation of human waste, proper inactivation of pathogens and decomposition of contaminants. Besides, hygienic latrines should enable recovery of nutrients and water in order to improve economic efficiency.

The MOH has recently issued the Manual with detailed designs of 12 types of hygienic latrines widely used in rural areas of Vietnam. The Manual can be used as a reference material in sanitation intervention projects. The MOH has developed a set of criteria on hygienic household latrines (National Code QCVN 01:2011/BYT). Latrines can be “wet” (using water for flushing) and “dry” (no water flushing). The criteria are set, covering construction, operation and maintenance stages. The 12 latrines presented in the Manual are: (1) ventilated improved pit latrine; (2) double vault composting latrine; (3) pour-flush toilet with single soak pit; (4) pour-flush toilet with single soak pit surrounded by infiltration enhancing sand belt; (5) pour-flush toilet with two soak pits; (6) septic tank constructed by bricks for treatment of black wastewater from squatting bowl toilet; (7) septic tank constructed by concrete sewer rings for treatment of black wastewater from squatting bowl toilet (Figure 1 and Figure 2); (8) Latrine with septic tank constructed by concrete sewer rings for flood-prone areas (Figure 3); (9) septic tank constructed by brick for treatment of black wastewater from sitting bowl toilet; (10) septic tank constructed by concrete sewer rings for treatment of black wastewater from sitting bowl toilet; (11) septic tank constructed by brick for treatment of black and grey wastewater from sitting bowl toilet; (12) septic tank constructed by concrete sewer rings for treatment of black and grey wastewater from sitting bowl toilet.



The latrines have been designed with minimum sizing required for proper treatment of excreta from a rural family with 4 members and average living condition. Water consumption for a household with an average number of 4 users is calculated with 2 lit/time of flush when defecating and 1 lit/time of flush when urinating at pour-flush squatting toilet, 6 lit/time of flush when defecating and 3 lit/time of flush when urinating at pour-flush sitting toilet. Each member of a household uses toilet 5 times per day (Nguyen V. A. et al, 2012).

Before selecting the type of latrine for its construction, the information about the cost of each latrine option and necessary construction materials are very crucial, as well as such information as specific local cultural, and socio-economical conditions.

Materials and methods

The cost estimation was based on unit costs of market construction materials stated in the Decision of 5481/2011/QĐ-UBND dated 24 November 2011 of the People's Committee of Hanoi. The estimation included only construction material cost for the toilet floor and toilet bowl, and the pit or chamber for excreta storage and treatment.

Annualized management cost of latrines was calculated based on the cost of toilet paper, water consumption (if any), additional materials (if any), labor cost for taking out and disposal or treatment of excreta per year. Water consumption was calculated for each type of toilet. Labor cost was calculated based on the frequency of pit emptying for each type of toilet: 2 times per year for the dry toilet (*MOH, 2012*), and 5 years for septic tanks (*Nguyen V. A., 2007, Nguyen V. A. et al, 2012*). Annualized depreciation cost was calculated based on 5 years of life span for the pit latrines, 7 years for a double vault composting latrines and pour-flush latrines, and 10 years for the septic tanks. Averted annual cost was calculated by adding annualized depreciation cost to annual O&M cost (*Nguyen V. A. et al, 2012*).

Results and discussions

Cost estimates for 12 types of latrine

The cost of construction and management of latrines has significant impact on selection of household toilets, especially among households in poor or near to poor groups. Table 1 presents results of cost estimation for all 12 types of latrines.

Type of latrine	Cost of construction materials (USD)	O&M cost (USD/person. year)	Averted annual cost (USD/person. year)	Note
Ventilated improved pit latrine (VIP)	37.52	1.86	3.74	Cost for pit and floor
Double-vault composting latrine (DVCL)	69.86	3.05	5.55	Cost for two pits and floor
Pour-flush (PF) toilet with single soak pit	62.85	3.79	6.03	Cost for pit, floor and squatting bowl
PF toilet with single soak pit and infiltration enhancing sand ring	81.04	3.79	6.68	Cost for pit, floor and squatting bowl
PF toilet with 2 soak pits	98.02	3.79	7.29	Cost for pits, floor, squatting bowl and diversion chamber
Septic tank (ST constructed by brick for treatment of black wastewater from squatting toilet	138.60	4.30	7.77	Cost for septic tank, floor and squatting bowl
ST constructed by precast concrete sewer rings for treatment of black wastewater from squatting latrine	83.69	4.30	6.40	Cost for septic tank, floor and squatting bowl
Latrine for flood-prone area with ST constructed by concrete sewer rings	72.27	4.30	6.11	Cost for septic tank, floor and squatting bowl

ST constructed by brick for treatment of black wastewater from sitting toilet	212.29	4.58	9.89	Cost for septic tank, floor and sitting bowl
ST constructed by concrete sewer rings for treatment of black wastewater from sitting toilet	141.27	4.58	8.11	Cost for septic tank, floor and sitting bowl
ST constructed by brick for treatment of black and grey wastewater (B+G) from sitting toilet	272.29	4.58	11.41	Cost for septic tank, floor and sitting bowl
ST constructed by concrete sewer rings for treatment of black and grey wastewater (B+G) from sitting bowl toilet	186.85	4.58	9.25	Cost for septic tank, floor and sitting bowl

As shown in the Table 1, VIP has the lowest construction cost of USD 37.52. This type of toilet is suitable for low-income households living in low dense areas with a low ground water table. The average income of families in midlands and northern mountainous and rural areas in Vietnam was estimated at less than USD300/capita per year in 2012, the lowest income regions in the country (*GSO, 2013*); the averted annual cost of VIP of USD3.74 /person per year accounts for 2% of per capita income.

In the group of dry latrines, the double-vault composting latrine has a number of advantages. With sealed composting chambers built above ground, the latrine can minimize risk of groundwater pollution, reuse of excreta in agriculture after proper composting/storage improves economic benefits. Averted cost for this type of latrine is USD5.55/person per year.

The pour-flush toilet with septic tank built from local pre-casted concrete sewer rings and squatting toilet bowl is the cheapest type among wet latrines. Averted cost for this type of latrine is USD6.4/person per year. The latrine can be used for low-income areas where water for flushing is available.

The pour-flush toilet with brick septic tank has highest construction (USD9.89/person per year) and operation costs (USD4.58/person per year). Use of locally available construction materials and appropriate water-saving sanitary facilities can help households to save money.

The range of costs of above latrines is still below target expenditure set by Gates Foundation Reinvent Toilet Challenge (USD18.3/person per year) (*BMGF, 2011*).

Figure 4 shows the averted annual cost of latrines made from different local materials.

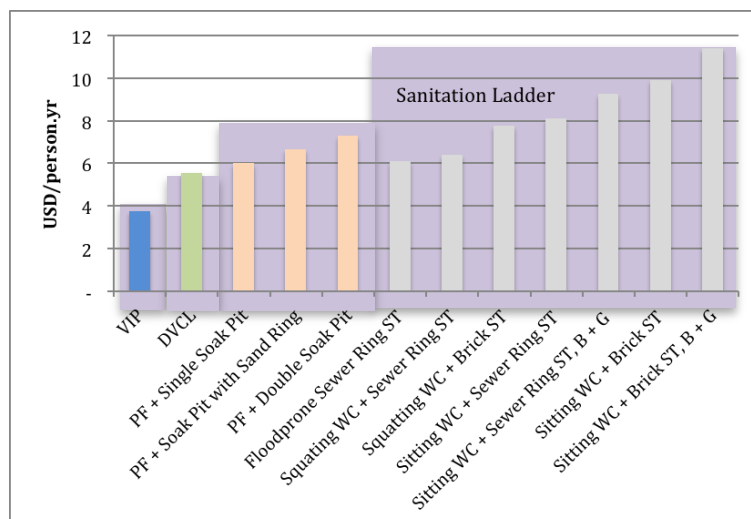


Figure 4. Averted annual costs of latrines

Note: See abbreviations in Table 1

As shown in Figure 4, construction materials play a very important role in searching for low-cost latrine construction. Using local available construction materials can make a toilet stand at a higher position in “Sanitation Ladder” and have a lower cost respectively. The cheapest option is VIP, and the most expensive latrine is septic tank constructed by brick for treating black and grey wastewater. Septic tank made from pre-fabricated sewer rings turned out to be cheaper than pour-flush and dry toilet made from bricks.

Solutions for reducing latrine construction costs

Using water-saving sanitary wares can help to reduce required volume of septic tank significantly. The minimum volume of a septic tank receiving black wastewater from squatting toilet, instead of sitting toilet, for a household with 4-6 people, can be reduced from 1.5 to 0.85 m³. Reducing the tank emptying frequency, for example, from 3 years to 2 years, could also help to reduce the tank volume, and as consequence to reduce toilet construction cost.

Using local materials for toilet construction is the most common solution of which the designer would have in mind. Superstructure of the latrine can be made from wood, bamboo, grass, plastic plates, soil, etc. Roof can be made from palm leaves, grass, corrugated fibro cement plates, etc. In order to compromise durability requirement and cost, a lower part of latrine wall can be made from brick, where a higher part can be made from local, cheap materials. The latrine floor can be made from bamboo, wood and sealed with soil plaster. The soak pit can be reinforced by local stone instead brick.

Pre-fabrication of toilet components in series is a common approach for example pre-fabricated floor slab made from fiber-glass, soak pit or septic tank made from pre-fabricated sewer rings, are among popular solutions.

Solutions for reducing latrine management costs

The minimum storage time of excreta from 6 to 12 months and use of appropriate additional material is necessary in order to create good conditions for the decomposition process and removal of pathogenic bacteria in dry toilets. In case of early emptying of the pit, due to pit getting full, a further composting or treatment of excreta outside the pit is required.

For latrines in flood-prone areas, complete sealing of pits or tanks during flood is necessary in order to prevent pathogens and contaminants spreading out.

Regarding wet latrines, it is necessary to train users not to put harmful substances into the tank since it can negatively affect the microbial activities and stop a whole treatment process in the tank. To ensure the efficient operation of the septic tank, the tank should be periodically emptied. Fecal sludge should be properly pumped out, transported, treated, and disposed of or reused.

As well as the cost of each type of latrine, there need to have some important factor for selection of the appropriate type of latrine; such as, the abilities to fit the latrine in specific local, natural, social, economic and cultural conditions A household toilet system should fit well to local water supply system. Moreover, a household toilet should be properly connected to the sewerage and drainage system of the residential area. The criteria guiding the selection of household latrines are presented as follows:

1. Can the household afford to build or to upgrade latrine?
2. What are the geological and hydro-geological conditions in the area? Is there a risk of contamination of water wells by latrines or not?
3. What are infrastructure conditions in the area? Is connection of the household drainage system to the community drainage network feasible or not (or if there is only one option for wastewater to infiltrate into the soil, discharge to the fish pond, etc.)?
4. What is the population density for each specific area of the location? Is there space available to build toilet outside of the house? Are latrines often built inside the house?
5. Is water source available, and enough for flushing of toilet or not? Or should household have alternative water supply source (e.g. rain water) for toilet flushing, in the case of wet latrine being applied?
6. Is there a need for reuse of fertilizers in agriculture or not?

Conclusions and recommendations

The cost of 12 sanitary household latrines in the Standard design set of the Ministry of Health using traditional construction materials is ranging from USD37.5 (VIP) to USD194.4 (Septic tank constructed by brick for treatment of black and grey wastewater from sitting bowl toilet).

Besides requirement of proper selection, design and construction of latrine, the latrine should be used and maintained adequately. Annual O&M cost of officially approved Vietnamese latrines range from USD1.86 (VIP) to USD 4.58 (wet latrine with septic tank) per capita per year.

Costs of hygienic latrines can be further reduced, applying solutions such as use of local materials for construction, reduction of the tank volume by using the water-saving flushing devices or applying more frequent tank emptying services, and mass production of latrine components, etc.

There remain a lot of room for continuation of research into these, innovative solutions, with the aim to create and provide new types of low-cost hygienic latrines, and consequently make sanitation more accessible for the poor.

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