Muhammed Alamgir, S.M. Tariqul Islam and J. A. Saju (Eds.)
ISBN: 978-984-35-4034-8

Full Paper of the WasteSafe 2023 –8th International Conference on
Integrated Solid Waste & Faecal Sludge Management
25-26 February 2023, Khulna, Bangladesh

ASSESSMENT ON FAECAL SLUDGE EMPTYING TECHNIQUES AT SELECTED AREAS IN BOGURA CITY

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ABSTRACT

Even though it is very necessary, emptying and disposal of faecal sludge is not handled properly in Bangladesh. The objective of this study was to evaluate the emptying techniques and categorize them into different groups as "safe, partially safe and unsafe" as well as "mechanical and manual". Three different types of area were selected which included residential area, mixed use area and slum area. The quality of emptying in residential area was found to be safe for 48%, partially safe for 31% and unsafe for 21%. The quality of emptying in mixed-use area was found to be safe for 33%, partially safe for 41% and unsafe for 26%. And for slam area the corresponding values were 16% for safe, 23% for partially safe and 61% for unsafe. The overall score and corresponding quality were found as partially safe for residential and mixed-use area whereas unsafe for slum area.

INTRODUCTION

History demonstrates that the human species has been concerned about sanitation for a very long time. With 2.4 billion people worldwide still lacking improved sanitation facilities (WHO and UNICEF, 2015), developing countries need to look at sanitation system and its development with a new lens. the importance of sanitation is a crucial stepping stone since 1.5 million children's lives can be saved each year thanks to sanitation (Agyei, 2009). Along with economic growth, it also has measurable economic benefits like improved health and education (Nkansah, 2009).

Bangladesh is falling behind in providing better sanitary facilities while making drastic progress in eliminating open deflection. Even the Millennium Development Goal (MDG)-7 was achieved by 2015. Bangladesh has significantly reduced open defecation, from 34 percent in 1990 to just one percent of the national population in 2015. However, the current rate of improved sanitation is 61 percent, growing at only 1.1 percent annually (The World Bank). But Faecal Sludge Management (FSM) is urgently needed in Bangladesh since untreated Faecal Sludge can harm the environment and health, especially of the country's poorest (Opel, 2011). A healthy number of people, to be specific in urban area, has a tendency to connect septic tanks directly to the environment, particularly water bodies, despite the huge negative impact.

The dietary intake of food and fluid are the primary links to faecal and urine composition entering sanitation facilities (Rose et al., 2015). Faecal sludge generally consists of all liquid and semi-liquid contents of pits and septic tanks of on-site sanitation system (Strande et al., 2014). The solid part usually settles down. FSM includes the storage, collection, transport, treatment and safe disposal of FS (Singh *et al.,* 2017).

Bogura is a city and the district headquarters of Bogura District in the division of Rajshahi, Bangladesh. It is a fast-growing city, which is 196 km away from Dhaka, the capital of the country. It is beside the Karatoa River and well connected with roads and railways (DPHE). According to the population census, in 2011 by the Bangladesh Bureau of Statistics (BBS), the Bogura city population was 400,983. The urban population growth in Bogura is 2.5% per year. Considering 10% floating population, such as farmers and traders, comes to the city every day, the present (2021) population is estimated to be around 550,850. According to the Feasibility study 2020-21/DPHE, almost all the households (98%) in the city have their own latrine, which is connected to single pits, twin pits, septic tanks, or discharged directly into the environment (e.g. open-drain or storm sewer). The rest of the households use community latrines (1.50%) and neighbour's toilets (0.50%). It was found that 29.41% of the city population uses septic tanks as the containment system, 52.00% of the toilets have single pit systems, and 16.50% of people use double pits in the city, 0.20% of toilets have unlined pits, no outlet or overflow and 1.90% do not have any type of containment and discharges directly to the environment (KII, FGDs, HH survey, 2020).

Households relying on septic tanks have to arrange themselves to empty the septic tank. However, about 67% of the septic tanks connected to the soak pit are emptied within 2-5 years. About 62% of the septic tanks connected to open drains, open groundwater bodies or 'don't know where are emptied within 4-5 years. Desludging of the septic tanks or pits is mostly (96%) done by private sweepers. Only in a few households, desludging is done by family members (3%) and by municipal sweepers (1%).

This study's specific goal is to find on-site containment emptying techniques in three different type of settlements in Bogura Municipality that can be classified as safe, somewhat safe, and unsafe.

EMPTYING TECHNIQUES OF FAECAL SLUDGE

The first step in Faecal Sludge Management (FSM) is containment, generally pits or septic tanks, which refers to the storage of human waste or excreta. With time faecal sludge are stored in containment and thus it needs to be cleaned after a specific interval of time, that is termed as emptying of faecal sludge. According to BNBC, it is advised to clean septic tanks between six months to one year. However, there is considerable lack of information and knowledge about the efficiency of fecal sludge emptying as a service and as a component or integrated part of the city's sanitation service.

Types of emptying techniques based on quality

Quality emptying techniques entail a safe workplace for both workers and the environment, as well as a quality combination of containment conditions and other infrastructure restrictions. The faecal sludge emptying techniques can be divided into five categories based on quality, which are environmentally safe emptying, safe emptying, partially safe emptying, and unsafe emptying and not ever emptied (Kabir and Salauddin, 2015). It is very rare, almost impossible to find environmentally safe emptying in Bangladesh and since the study is about emptying quality techniques, environmentally safe emptying and not ever emptied can be ignored.

Safe emptying

Safe emptying means not polluting the environment, and being safe for the emptiers. Safe emptying, transportation, and disposal of sludge are extremely important for public health as well as for the social and environmental benefits it brings (Franceys et al., 1992). It ensures that sludge is not released into the environment directly and that the confinement has been emptied in the past three years. It also means that the procedure is completely mechanical.

Partially safe emptying

A modified type of emptying procedure that falls between safe and unsafe emptying is referred as partially safe emptying. It has frequently been described as intermediate emptying, which denotes that while primarily safe emptying is taking place, a little amount of unsafe emptying is also taking place. In this case the sludge has no dedicated place to be dumped. However, it is not directly discharged into the environment. The frequency of faecal sludge emptying is not less than three years but limited to five years. The procedure for partially safe emptying is a combination of both mechanical and manual emptying.

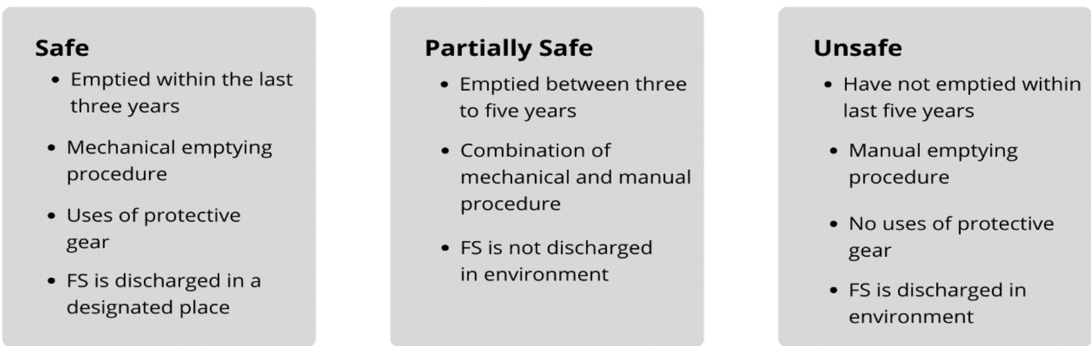

Figure 1 Selection criteria for emptying techniques

Unsafe emptying

When the environmental pollution and a certain health hazard have come to account due to the bad emptying of pit and septic tanks, then it can be said unsafe emptying (Franceys et al., 1992). When sludge is released directly into the environment, pits have not been emptied in the previous three years, or emptying is performed by someone entering the confinement without protective gear, the degree of unsafe emptying is noted. According to Repon *et al.,* 2015, individuals or informal private sector businesses manage faecal sludge in an unorganized, disorganized, unclean, and poorly regulated manner all over Bangladesh.

Table 1 Selection criteria of emptying techniques

Emptying techniques	**Selection criteria**
Safe Emptying	Within the previous three years, all containers older than three years have been emptied. Complete mechanical procedure. Protective gears were used by emptiers. Instruments used were completely safe. There was no spillage. Dedicated place for dumping faecal sludge.
Partially Safe Emptying	Not during the previous three years, but less than five years ago, containment was emptied. Combination use of the mechanical and manual procedures. Lack of willingness for mechanical method. No dedicated place for dumping. Is not discharged directly into the environment.
Unsafe Emptying	Households are unaware of periodic emptying. Containment was not emptying within the last five years. Completely manual method where a person needs to get inside the tank. No use of protective gear. There is a significant amount of spillage while the procedure. Uses of the unsafe instrument. Directly discharged into the environment.

METHODOLOGY

This section describes the study's methodology and outlines the steps involved in conducting the research. It includes the selection of the area, selection of indicators, sampling method, extensive data collection, data entry and analysis procedure.

Selection of study area

Bogra District (rajshahi division) has area of 2898.25 sq km, located between 24°32' and 25°07' north latitudes and in between 88°58' and 89°45' east longitudes. It is bounded by joypurhat and gaibandha district on the north, chalan beel,' natore and sirajganj district on the south, Jamuna river and Jamalpur district on the east, part of Chalan Beel and naogaon and Natore district on the west. It has a population of total 3013056; male 1547341, female 1465715; Muslim 2819432, Hindu 191528, Buddhist 666, Christian 297 and others 1133. The study requires three different types of settlement such as residential area, mixed used area and slum area all of which are found in Sherpur Upazila. Thus Sherpur Upazila was selected.

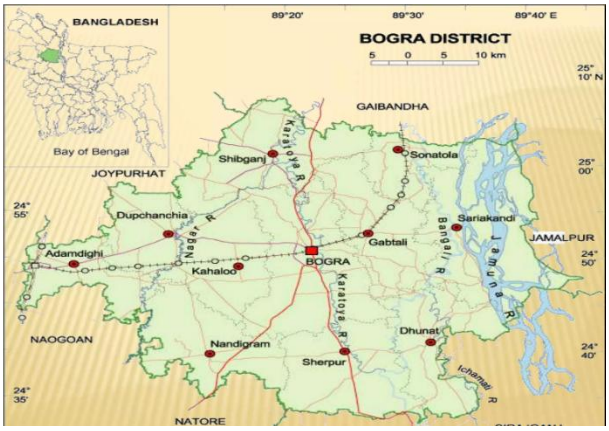

Figure 3 Map of Bogura district

Figure 2 Map of Sherpur upazila

Selection of Indicators

The study focuses mainly on emptying techniques quality divided into broadly three categories as safe emptying, unsafe emptying and moderate emptying also known as partially safe emptying. To decide which category to fall into, few indicators were evaluated based on containment, emptying details and users awareness and knowledge.

Table 2 Determination of Indicators

Criteria	Indicators
Containment	Size and condition Location & Accessibility Outlet connection
Emptying	Emptying type Emptying service providers Emptying frequency Safety issues Cost and efficiency Disposal of Faecal sludge
Users Knowledge & Perception	Containment infrastructure Policy and regulations Mechanical emptying provision

Calculation of sample size

The sample size was calculated based on the total number of containment in the selected areas. Here the sample size was assumed to have a 95% confidence level and a 5% confidence interval. In order to find the sample size, a stratified sampling method was used. The sample was calculated using Equation 1 (Sudman et al., 1982).

$$Sample\ size, \quad n = \frac{Z^2 pqN}{e^2(N-1) + Z^2 pq} \tag{1}$$

Where,
N= Number of household
Z= The nominal variants (1.96 for 95% confidence level)
p= 0.5, q= 0.5, e= 0.05
The sample size is distributed according to the total number of containment of each location and modified for three different types of settlements, as shown in the table below

Table 3 Distributed sample size for selected areas

Upazila	Location Name	Number of Containment	Calculated Sample Size	Distributed Sample Size
Sherpur	Sherpur sadar	836	313	157
	Jaynagar	559		105
	Kusumbi	271		51

Administration of Questionnaire

For each parameter under each indicator, there were three sections in the questionnaire: unsafe emptying, partially safe emptying, and safe emptying. The target for the questionnaire was generally the house owner for that he could give extensive information for the containment. For unsafe emptying, a score of 0 was given, and 0.5 and 1 were given for partially safe emptying and safe emptying respectively. The questions were repeated often to ensure the consistency of the answers.

Data entry and analysis

By questionnaire, household information of a total of 313 houses was collected and the data were processed in Standard Package for Social Science (SPSS) software. For the purpose of preparing the data input, the variables have been chosen and identified. And then, the data were converted to a Microsoft Excel spreadsheet for further analysis.

Table 4 Designated score for different responses

RESPONSES FOR INDICATORS	SCORE
SAFE	1
PARTIALLY SAFE	0.5
UNSAFE	0

To determine the quality of emptying techniques, indicators of containment, emptying and users knowledge and perception were evaluated. Firstly, all the responses for each indicator were categorized as safe, partially safe and unsafe. Then, a score of 1, 0.5 and 0 was awarded for safe, partially safe and unsafe responses which were also used by Islam (2017). After that, the weighted value for different parameters was calculated from the data using equation 2.

$$Weighted\ value, \quad WV_n = \frac{Res\ (Unsafe) \times 0 + Res\ (Partially\ safe)\ \times 0.5 + Res\ (Safe)\ \times 1}{N_j} \quad (2)$$

Where,
WV_n = Weighted value for "n" parameter
Res = No. of Responses and
N_j = Total No. of Responses
Equation 3 has been used to find the quality of the emptying technique scores for each indicator after obtaining the weighted value for each parameter.

$$Average\ weighted\ value, \quad AWV_n = \frac{\sum Weighted\ value(n)}{N_i} \quad (3)$$

Where,
AWV_n = Average Weighted Value for "n" indicator
N_i = Total No. of indicators
Then, the prioritized weighted value (PWV) was calculated by multiplying the average weighted value with the priority factor according to Table 5 using Equation 4.

$$Prioritized\ weighted\ value, \quad PWV_n = AWV_n\ \times priority\ factor \quad (4)$$

Where,
AWV_n = Average Weighted Value for "n" indicator
PWV_n = Prioritized Weighted Value for "n" indicator
From here, Equation 5 has been used to get the overall quality of emptying techniques score for each location.

$$Quality\ of\ Emptying\ technique, \quad QE_x = \frac{\sum PWV_n}{N_i} \times 100 \quad (5)$$

Where,
QE_x = Quality of Emptying techniques at "x" settlement
PWV_n = Prioritized Weighted Value for "n" indicator
N_i = Total No. of indicators

Table 5 Priority factor for average weighted value

Quality	AWV	Priority factor
Safe	0 - 33	0
Partially safe	34 - 67	0.5
Unsafe	68 - 100	1

RESULTS AND ILLUSTRATIONS

This part elaborately explains the present confinement emptying process inquiry and quality of emptying procedures determination, as well as the study's output and results.

Existing Emptying Techniques

It has been discovered that the research region mostly uses two sorts of emptying processes which are manual emptying and mechanical emptying.

Manual Emptying

It is traditionally performed by sweepers who are easily available only by phone call. They empty the septic tank using a bucket and a boggy or trailer is used to transport the sludge using an engine. The capacity of one boggy is usually 300 liters. To empty the solid portion of the sludge, they frequently have to enter the septic tank. If the land is available, they may occasionally construct a ditch next to the containment; if not, they just dump it into the drain or a water body. Many people use the manual emptying process just because they are unaware of the mechanical emptying process and the availability of sweepers.

Mechanical Emptying

In this city, the proportion of mechanical emptying is comparatively low as compared to manual emptying. In this method, the septic tank is cleaned using Vaccum by vacutugs which are generally carried by tractor. However, it requires a wide and large road to access and the cost is comparatively high. This is the reason many people avoid the mechanical emptying process.

Quality of Emptying Techniques

As previously noted, the effectiveness of emptying processes may be divided into three categories: unsafe emptying, partially safe emptying, and safe emptying. The emptying quality is determined by quantitative analysis based on a questionnaire survey.

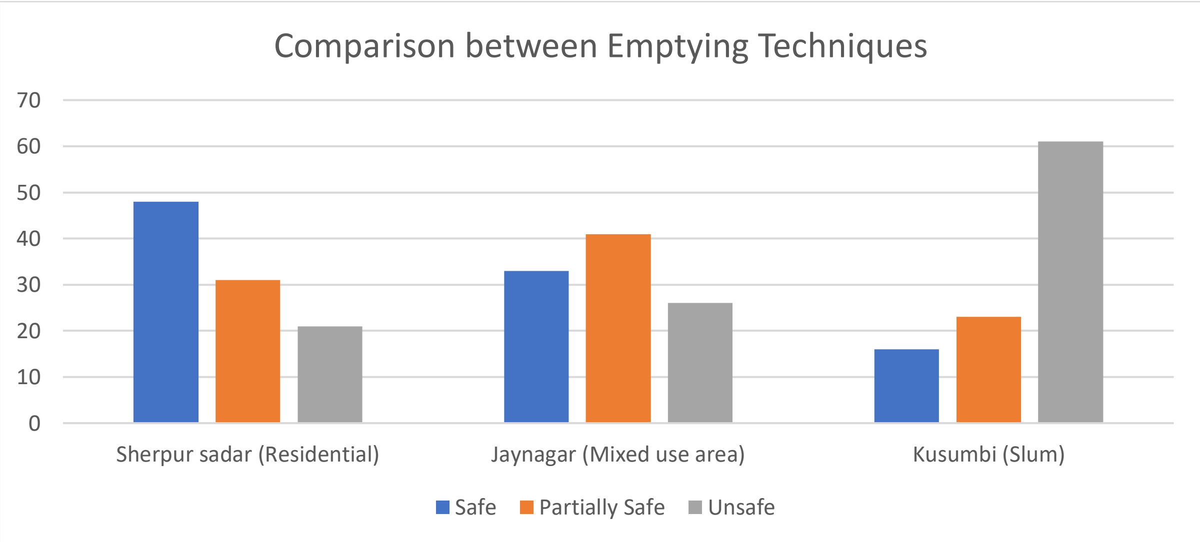

Figure 4 Comparison between Emptying Techniques

Figure 4 demonstrates the distinctive quality of emptying processes, including unsafe emptying, partially safe emptying and safe emptying. As a residential area, emptying techniques in Sherpur Sadar are found to be safe for 48%, unsafe for 21%, and partially safe for 31%. Septic tanks are the most common method of containment in a residential area, and they are generally acceptable in terms of size. That is the reason for the comparatively high percentage of safe emptying. Mixed-use areas are found to have safe emptying for 33%, partially safe for 41%, and unsafe for 26%. The corresponding values for the slum area were 16% for safe, 23% for partially safe, and 61% for unsafe. It results from a number of factors, including frequent emptying, ignorance of mechanical maintenance, etc.

Each type of settlement's overall quality of emptying techniques has been assessed, showing the area's current emptying practice. According to Table 5, the priority of each indicator under containment, emptying, knowledge, and user perception is used to determine the overall quality of the emptying procedures score.

Table 6 Overall emptying quality

Area	Quality score	Overall Quality
Residential	46.3	Partially Safe
Mixed use	37.8	Partially Safe
Slum	20.4	Unsafe

CONCLUSIONS

Private sweepers predominantly empty containments manually, with only a very small fraction of containments being emptied mechanically. During emptying operations, all emptiers—manual and mechanical—ignore safety concerns. The quality of emptying in residential area was found to be safe for 48%, partially safe for 31% and unsafe for 21%. The quality of emptying in mixed use area was found to be safe for 33%, partially safe for 41% and unsafe for 26%. And for slam area the corresponding values were 16% for safe, 23% for partially safe and 61% for unsafe.

Finally, Sherpur Sadar, Jaynagar, and Kusumbi obtained scores of 46.3, 37.8 and 20.4, accordingly for the overall quality of the emptying processes. This score indicates that Sherpur Sadar and Jaynagar currently have partially safe emptying, while Kusumbi has unsafe emptying.

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