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ASSESSING THE EXISTING CONTAINMENT MANAGEMENT PRACTICES OF FAECAL SLUDGE IN A WARD OF KHULNA CITY

Sabok Mondal[1], S. M. Moniruzzaman[2] and Md. Shofiqul Islam[3]

[1] Post-graduate Student, Department of Civil Engineering, Khulna University of Engineering & Technology, Bangladesh, e-mail: sabok.mondal@gmail.com
[2] Professor, Department of Civil Engineering, Khulna University of Engineering & Technology, Bangladesh, e-mail: monir_ce92@yahoo.com
[3] Post-graduate Student, Department of Civil Engineering, Khulna University of Engineering & Technology, Bangladesh, e-mail: ngdcshopon@gmail.com

ABSTRACT

Faecal sludge (FS) is the human excreta both in liquid and semi-liquid contents which stored in pits and septic tanks accumulating in on-site sanitation and Faecal Sludge Management (FSM) refers to the containment, emptying, transport, treatment, and safe disposal of human waste. In this study, the aim is to identify the on-site containment management practices at three different types of settlements in Ward No. 9 of Khulna City Corporation (KCC). The three types of settlements has been selected as a residential area, a mixed-use area and a slum area. The study has been conducted by a series of questionnaire survey and analysed by Standard Package for Social Science (SPSS) and Microsoft Excel software. The study finds that only 7% of septic tanks having soak well and rest of the septic tank is connected to a nearby drain or water body in the residential area. Again, 81% of the containment is suitable and accessible for mechanical emptying as 77% in the residential where about 41% containment is accessible and 59% are not in the mixed-use area. In the residential area, 58% of containment has not emptied yet where this percentage is 41% and 5% respectively for mixed-use and slum. The study also reveals that about 31% of the septic tank has been emptied by manually where only 13% is mechanically in the residential area. However, for the mixed-use area, manual emptying is about 50% and mechanical emptying is about 7% where all emptying operations have been done either manually or self. In all three areas, the emptied sludge is disposed of off to nearby drains if emptied by manually and disposed to Khulna Faecal Sludge Treatment Plant (FSTP) if emptying is done by mechanically.

Keywords: *Faecal Sludge, Faecal Sludge Management, Containment, Emptying.*

1. INTRODUCTION

Sanitation has been a matter of concern to the human race for a very long time. According to WHO (2008), the importance of sanitation is indisputable. It is a crucial stepping stone to better health that sanitation offers us the opportunity to save the lives of 1.5 million (Agyei, 2009) children a year who would otherwise succumb to diarrheal diseases, and to protect the health of much more. It is also key to economic development such as education and health, and bring measurable economic returns (Nkansah, 2009). Bangladesh has reached to her goal of improved sanitation and mostly completed the Millennium Development Goal (MDG)-7 by 2015 (Islam, 2016). According to JMP (2015), Open defection has reduced from 19% in 2000 to 3% in 2012, though 53% of households still do not use improved sanitation. Bangladesh has shown remarkable progress in sanitation sector, so it's urgent need for Faecal Sludge Management (FSM) in Bangladesh (Islam, 2016) mainly in urban areas, where most human waste is dumped untreated into waterways or onto marginal land, harming the health of the country poorest (Opel, 2011). Most of the cities in Bangladesh, including the third largest city Khulna (Islam, 2012) and one of the most climate vulnerable cities in the world (Haque, 2013) having a population around 1.5 Million (KCC, 2017) has no sewer network. In Bangladesh, sanitation coverage is unhappily inadequate with about 15% in urban and about 6% in rural areas as of 2006 (WHO, 2008). There are also instances

where faecal sludge are disposed of into the environment untreated (Murungi and Peter, 2014). Urban populations are growing very rapidly due to economic migration. As a result, most city residents connect their septic tanks directly to drains and local water bodies which is risky for the environment and have been unable to regulate pollution effectively despite the detrimental effects on the environment or the public health threat (Opel, 2006).

Faecal sludge comprises all liquid and semi-liquid contents of pits and vaults accumulating in on-site sanitation system, namely un-sewered public and private latrines or toilets, aqua privies and septic tanks (Strande et al., 2014). The solid part that has been the partially digested and settled at bottom of the onsite sanitation systems is known as fecal sludge (Koottatep, 2014). Faecal Sludge Management (FSM) includes the storage, collection, transport, treatment and safe enduse or disposal of FS that means all five component of the sanitation value chain (Singh et al., 2017). FSM is important because although over a billion people in urban and peri-urban areas of Africa, Asia, and Latin-America are served by on-site sanitation technologies, FS is not well managed in many cities (Murungi and Peter, 2014).

Khulna, the third largest metropolitan city in Bangladesh where the inadequate emptying option is found for FS (Kabir and Salauddin, 2015). In this city, about 628,070 m3 (Islam, 2016) of FS is produced every year. Unfortunately, in Khulna City Corporation (KCC) the entire FSM process is unsystematic and mainly maintained by informal private service providers (Islam, 2016). Hence the households are connecting the toilet to a drain. In Khulna city, about 84% of the total have a septic tank (Kabir and Salauddin, 2015) are connected to a drain or surface water. The practice of safe septic tank emptying is almost absent in Khulna city. More than half of the total households, irrespective of wealth situation, either use unsafe emptying or do not at all practice fecal sludge emptying. Safe disposal and treatment of fecal sludge are mostly absent in Khulna (Kabir and Salauddin, 2015).

The specific objective of this study is to identify the existing management practices of on-site containment at three different types of settlements in Ward No. 9 of Khulna City Corporation (KCC).

2. METHODOLOGY

In this section, the methodology to conduct the study has been described and also represents the steps of the research work process. The methodology also includes study area selection, sampling, extensive data collection and analysis procedure.

2.1 Study Area Selection and Description

Khulna is the third largest metropolitan city and situated in the south-western part of Bangladesh. The area of the total city corporation is 45.65 km^2. The population in this city is about 1.5 million with a density 67994 per km2. KCC has in total 31 wards with 66,257 holdings (KCC, 2017).

This study mainly focuses on the emptying of three types of settlements for the assessment. The first type of settlement is a planned residential area, the second one is a mixed-use area and the last one is a slum area. This three types of settlements have been found in Ward No. 09 in Khulna City Corporation. For this reason, Ward No. 09 is selected as the study area.

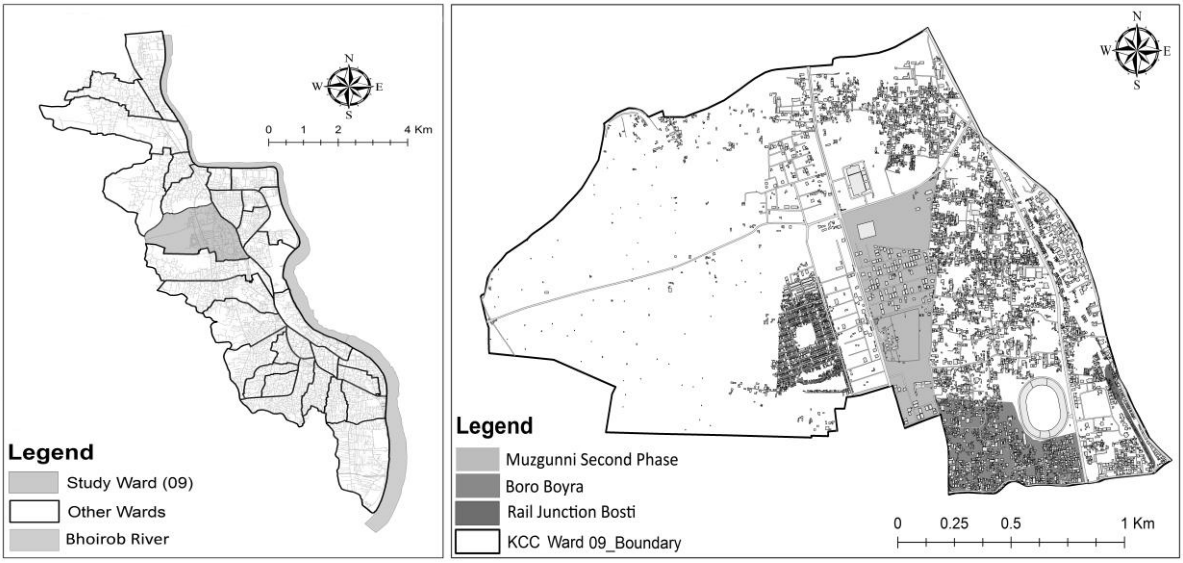

Figure 1: Study area location of Ward No. 09

2.2 Selection of Indicators

The research focus is mainly on the assessment of emptying quality determination. But emptying of FS has been linked with containment management practices and knowledge and perception of the users. In baseline survey by SNV (2014), Kabir and Salauddin, 2015 divided the emptying provision into five criteria. Applying some modification here the emptying quality has been divided into three categories namely unsafe emptying, safe emptying and moderate emptying that means partially safe emptying.Table 1: Indicators of containment management.

Table 2: Indicators for existing containment management

Criteria	Indicators
Containment	Containment size
	Containment condition
	Containment location & accessibility
	Containment outlet connection
Emptying	Emptying type
	Emptying service providers
	Emptying frequency
	Safety issues
	Emptying cost
	Vacutug efficiency
	Disposal of FS
Users Knowledge & Perception	Containment infrastructure
	Policy and regulations
	Mechanical emptying provision

2.3 Sample Size Determination and Questionnaire Administration

The questionnaire has been prepared in such way that there are three portions i, e; unsafe emptying, partially safe emptying and safe emptying for each parameter under each indicator. That's why the questionnaire has been prepared into three sections for each question. The first portion of the question is for totally unsafe emptying and will get score 0, then the middle part of the answer is moderate which means partially safe emptying and will get score 0.5. And the last one is for safe emptying which gets score 1. Actually, the households have asked questions with respect to these parameters. The questionnaire

target is the house owner who can give the extensive information about the containment. The questions have repeated sometimes to check the consistency of the answers.

The sample size has been calculated based on the total number of containment of the study area. A stratified random sampling method has been adopted for this study and sample size has determined to assume 95% confidence level and 5% confidence interval. The sample size calculation formula for the whole study area has been shown in equation 1.

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

Where,
N= Number of household
Z= The nominal variants and which has 1.96 for 95% confidence level
p=0.5, q=0.5, e= 0.05

The sample size is adjusted for three types of settlements using that formula and distributed according to the total number of containment each.

Table 2: Distributed sample size for specific study area

Ward No.	Area Name	Number of Containment	Calculated Sample Size	Distributed Sample Size
09	Muzgunni Second Phase	156	234	62
	Boro Boyra	330		131
	Rail Junction Bosti	105		41

The questionnaire has been prepared in such way that there are three portions i, e; unsafe emptying, partially safe emptying and safe emptying for each parameter under each indicator. That's why the questionnaire has been prepared into three sections for each question. The first portion of the question is for totally unsafe emptying and will get score 0, then the middle part of the answer is moderate which means partially safe emptying and will get score 0.5. And the last one is for safe emptying which gets score 1. Actually, the households are asked questions with respect to these parameters. The questionnaire target is the house owner who can give the extensive information about the containment. The questions are repeated sometimes to check the consistency of the answers.

2.4 Data Entry and Analysis

After collection of total 234 household information, the data has firstly entered and processed in Standard Package for Social Science (SPSS) software. The variables have selected and identified for the preparation of data input. After completing data input, the data have converted to a Microsoft Excel spreadsheet for further analysis.

Averaging the responses of unsafe, partially safe and safe emptying for each parameter has been obtained from the SPSS software and necessary illustrations have made for the results from this data.

3. RESULTS AND ILLUSTRATIONS

This sections describes the output of the study and reveals elaborately the existing containment management practices. Also, the comparison has been shown for each component of FSM indicator taken among the three study areas.

3.1 Existing Containment Management Practices at the Study Area

To evaluate the existing containment management practices in the three types of study areas, extensive data collection and analysis has been conducted. Different management

types issues i.e. containment types, containment suitability, containment outlet connection, ever emptied or not, emptying types, emptying service providers, emptying frequency, and disposal facilities etc. component of the research have been revealed and compared among the three study areas in this section.

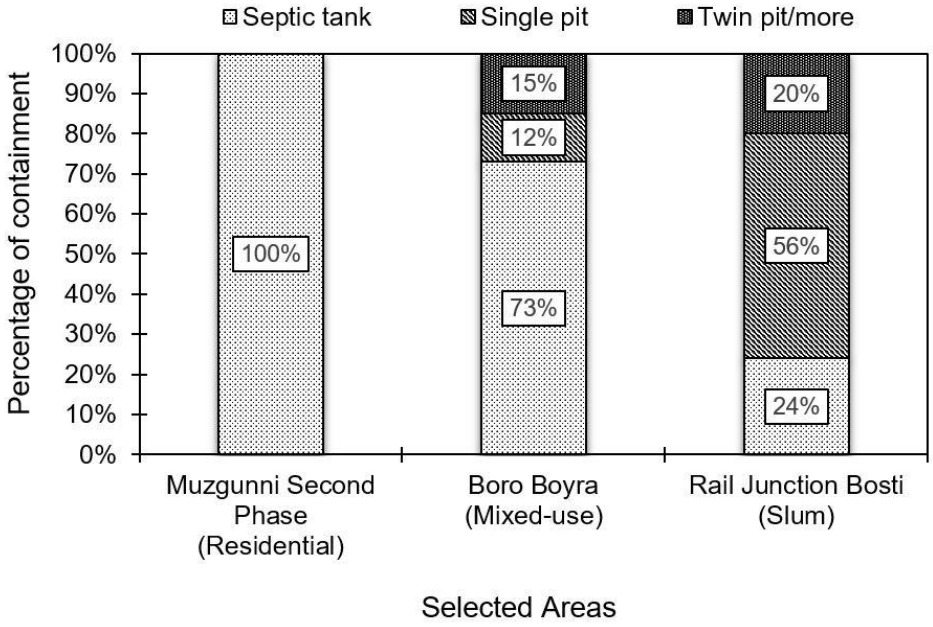

Figure 2: Containment types of the study areas

At first, the containment types have been described in the following and shown in figure 2. Muzgunni Second Phase as a residential area, 62 No. household has been surveyed and found all the containment is the septic tank. However, both the septic tank and the ordinary pit has been found in mixed-use and slum. About 73% of containment is septic tanks and remaining 27% is pit latrine in this area where the single pit is 12% and the twin pit latrine or more is 15%. In Rail Junction Bosti as the slum area, 41 households have been surveyed where pit latrine is dominant than septic tank. About 76% of containment is found as pit and only 24% is septic tank. In pit latrine, the single pit is 56% and twin pit is 20%. In slum area, the low-income community is living here and most of the people here are a worker, day labour.

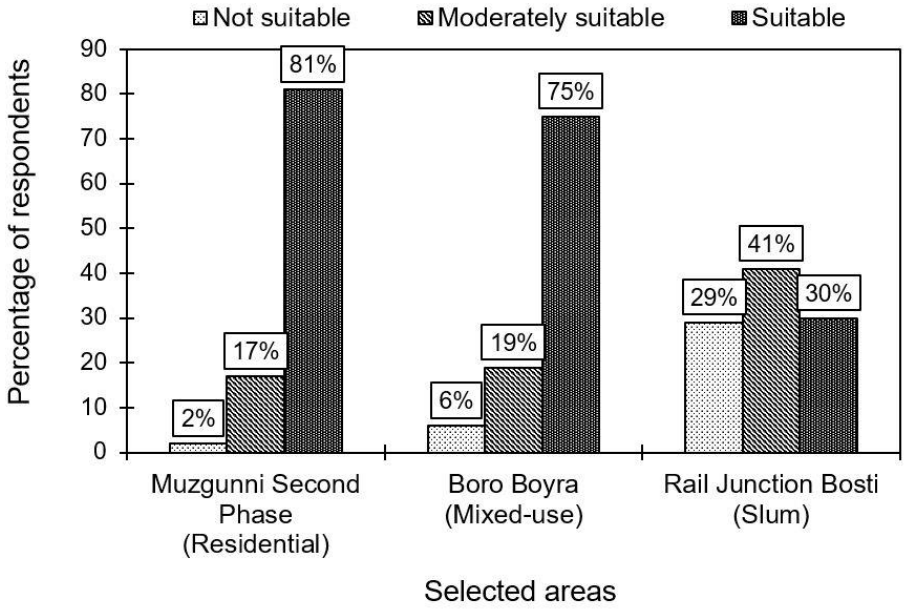

Figure 3: Containment size suitability of the study areas

Figure 3 describes the containment suitability of the study area and it is classified into three categories namely suitable, moderately suitable and not suitable. When the containment size is less than the size needed according to the number of users is termed as not suitable containment. But when the size of containment is optimum, termed as moderately suitable and if the containment has enough according to users said to be suitable. Containment size is determined by the field observations practically. Where theoretically the size is found by the number of users multiplying by the per capita accumulation rate and then matching with the previous one. However, containment size suitability is linked with the combined scoring of no. of the user, permission is taken from the authority, proper design.

From this figure4, a total 62 household are surveyed for the residential area and the majority of the containment is suitable where only 2% of containment is not suitable with respect to size. Almost same criteria have been found in the mixed-use area where about 75% of containment is suitable, 19% is in moderate and 6% is not suitable. Similarly, 49% of containment is suitable, 41% is in moderate and rest 10% is not suitable in the slum. In the slum, the percentage of containment unsuitability and moderate is more than other two area.

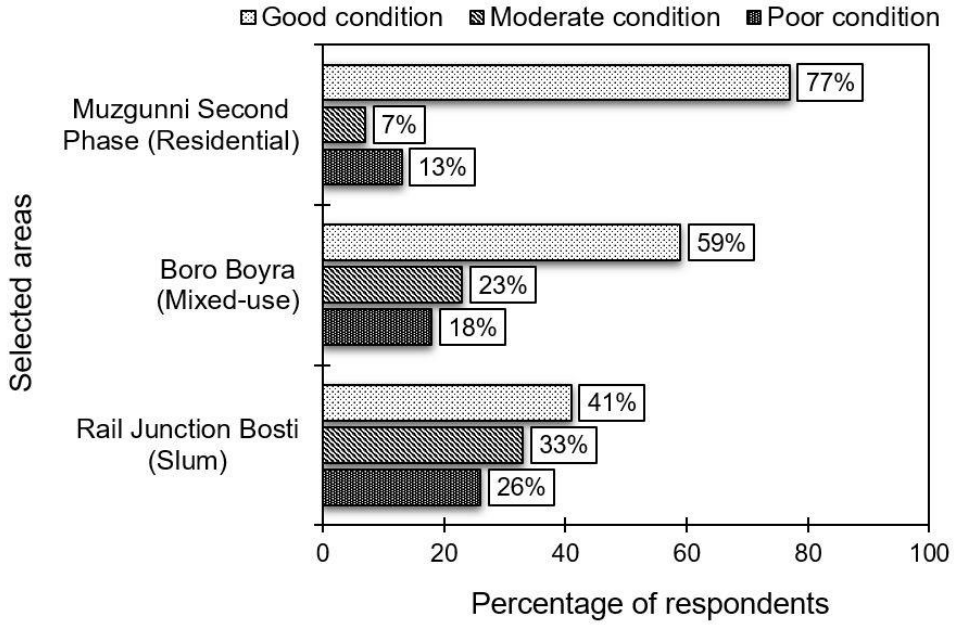

Figure 4: Containment condition at the study areas

Figure 4 describes the containment condition of the selected study area. It is found by the combined scoring of leakage, overflow, the frequency of facing a problem, types of the problem, the condition of the cover slab and checking the frequency of containment. To describe the containment condition, it has been classified into three categories e.g. good, moderate and poor. Containment is in good condition means the containment is structurally safe, have not any leakage, doesn't overflow during any season, no problem faced, etc. which can be considered as safe. Containment is in poor condition means the containment is structurally unsafe, the cover slab is open and broken, having leakage, overflowing in all season, frequently problem faced, etc. which can be considered as unsafe. And finally, containment is in moderate condition means the containment is between in good and poor condition.

From the Figure 4, it is also seen that containment condition is found good in most of the household in almost all three types of area. About 77% of containment are in good condition, 10% are in moderate and 13% are in poor condition in the residential area. Similarly, it shows that 59% of containment are in good condition, 23% are in moderate and 18% are in poor condition at the mixed-use area. And in the slum area, it has been shown

that 41% of containment are in good condition, 33% are in moderate and 26% are in poor condition. It is obvious that the condition of containment is better in Muzgunni Second Phase and worst in Rail Junction Bosti.

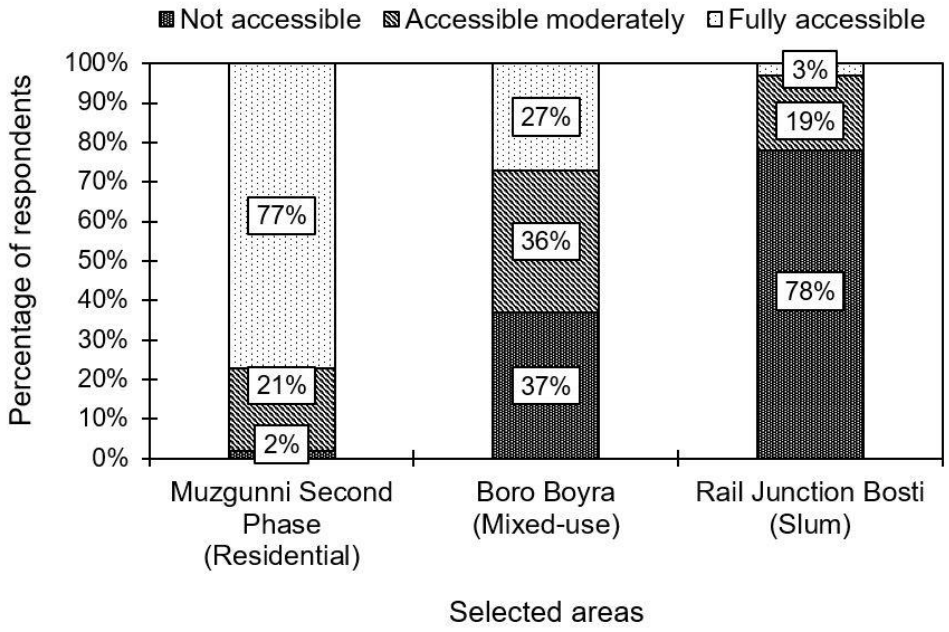

Figure 5: Containment accessibility for mechanical emptying at the study areas

Figure 5 describes the containment is accessible or not for the mechanical emptying operation of the study area. It is determined by the combined scoring five variables i.e. types of road, road width, the distance of containment from the road, the location of containment of the building and any obstruction to get the containment during emptying.

From this figure 5, it has been found that most of the containment are accessible for emptying operation by both manually and mechanically at the residential area where 77% of containment are easily accessible, 21% of containment are moderately accessible or partially accessible that means containment is accessible by removing some removable obstacles and around 2% of containment are not totally accessible for emptying operation. The main cause for not accessible is narrow road width or the long distance from the roadside or the non-removable obstacles to get the containment.

Similarly, for the mixed-use area, it is seen that 37% of containment is not totally accessible for emptying where 36% and 27% of containment are accessible moderately and easily accessible respectively. The AB Siddique road and Jhurivita road in this area are not fully accessible for vacutug entry due to its narrow road width and some of the containment is situated long distance from the roadside. For this reason, the percentage of accessibility has been decreased. In the slum, 81% of containment is not totally accessible because this slum is situated beside a rail line and the people use rail line as their road. A small portion of the slum beside a road in which a vacutug can get an entry. So for this reason, most of the containment to are inaccessible for mechanical emptying. About 19% of containment are moderately accessible and 3 % are fully accessible.

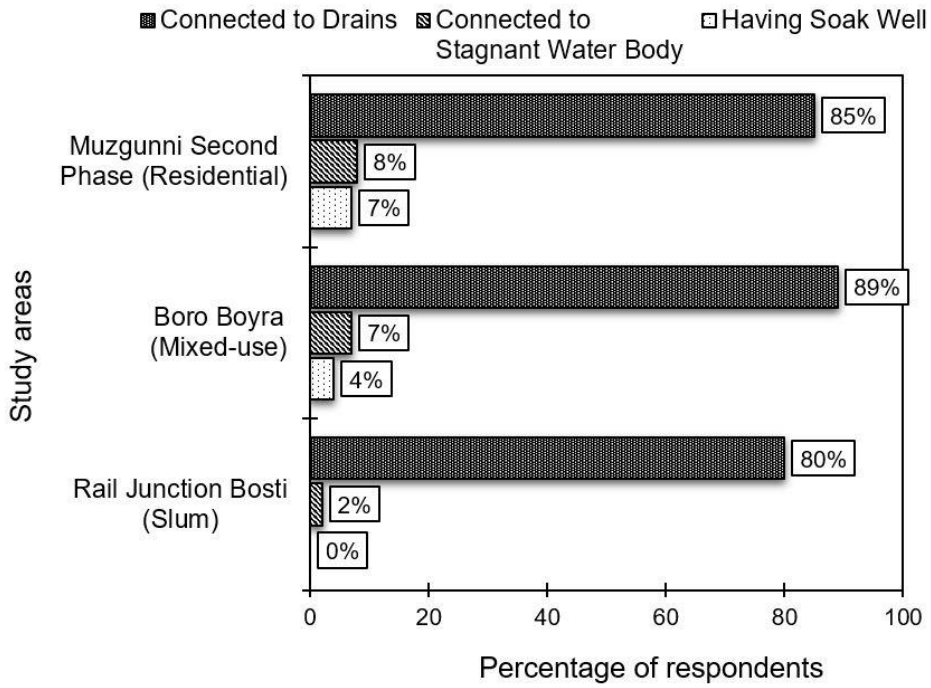

Figure 6: Septic tank outlet connection at the study areas

One of the main issues of containment management indicators is outlet connection of septic tank and figure 6 describes it for the study area. There is no sewerage facility in Khulna City. For this reason, most of the containment is connected to nearby drains or stagnant water body and it is 85% to drain and 8% to ponds or stagnant water body in the residential area. A small number of the septic tank has to soak well and its quantity is 7%. On contrary, a total 131 respondents are surveyed and found that most of the septic tank (89%) are connected to roadside drains and about 7% of the septic tank is connected to stagnant water body as shown in Figure 4.5. Like as the residential area, a small number of the septic tank has to soak well and it is only 4%. For Rail Junction Bosti area, it has been found that no septic tank have to soak well except the community-based toilets septic tank. Like that as the residential and the mixed-use area, most of the septic tank is connected to nearby drains and it is about 80%.

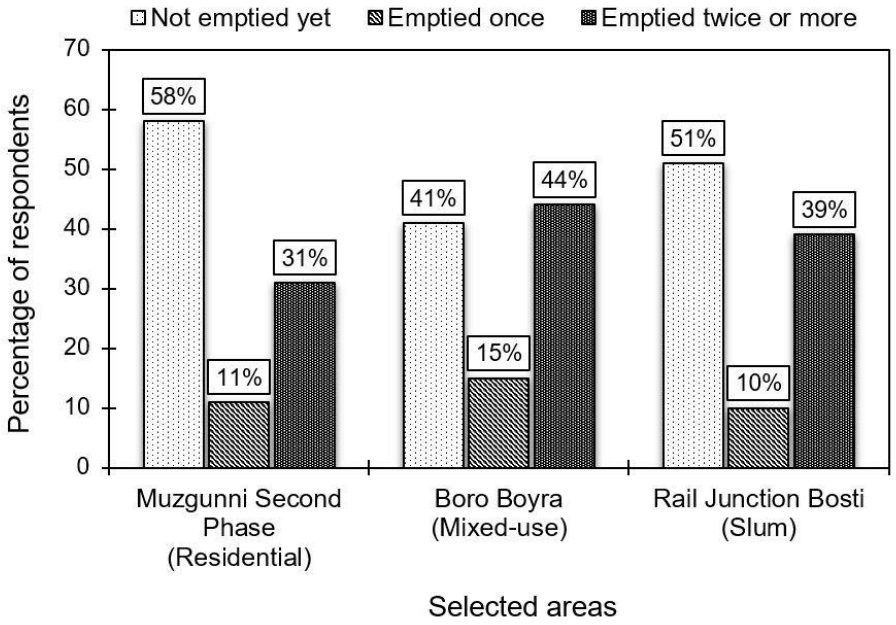

Figure 7: Containment emptied ever or not in the study areas

Figure 7 describes the containment emptied ever or not for the study area. About 58% of respondent have emptied their containment yet where 11% are emptied once and 31% are emptied twice or more times at the residential area. In this area, most of the septic tank is big and suitable according to the number of users. For this reason, it takes a long time to fill up and the respondent do want to empty until it completely fills. Again, some user linked their septic tank to nearby drain in such way that they do not need to empty ever because all the sludge goes to drain through the outlet connected pipe. But in the mixed-use area, emptying percentage has slightly increased and it is 44%. Similarly, in the slum area, 51% of respondent have not taken emptying service ever, 10% are emptied once and 39% are emptied twice or more times.

Emptying types of containment have been shown in figure 8 and it is seen that most of the containment have emptied by manual emptying process in all three types of the study area. It also shows that a big portion of people are not emptied their septic tank in the residential area and its quantity is 58%%. This cause is most of the respondents building is new and age of these building is about 6-8 years. On contrary, 42% of the septic tank is emptied. Emptying is done by the manual process is 29% and the mechanical process is 13%.

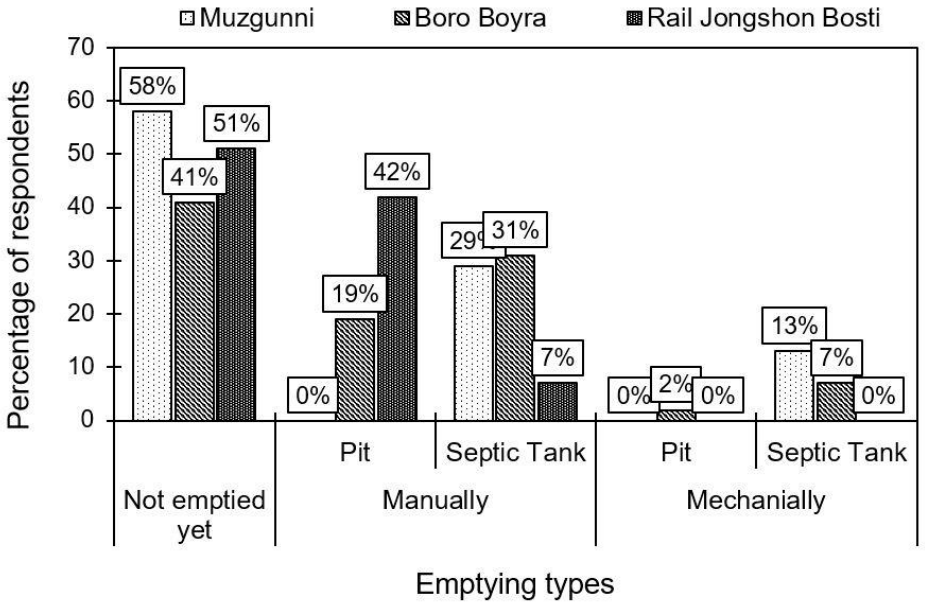

Figure 8: Emptying types of containment in the study areas

In the residential area, about 47% of people know about the mechanical service of emptying but the respondent is not willing to empty their septic tank by a mechanical process. It has been also identified that the average cost for manual emptying process and mechanical emptying process is found approximately 1500 BDT and 3000 BDT respectively. Again, from the figure 8, at the mixed-use area, 41% containment have not emptied ever where 19% of pit and 31% of septic tank have emptied manually.

Again the percentage of mechanical emptying is very low in this area and 2% of pit and 7% of septic tank emptied mechanically. The average cost for manual emptying process and mechanical emptying process is found approximately 1200 BDT and 2500 BDT respectively. In a similar way, at the slum area, 51% containment have not emptied ever where 42% of pit and 7% of septic tank emptied manually. No mechanical emptying is occurred in this area due to vacutug inaccessibility. It has been mentioned that this slum is situated beside a rail line. There is no road by which a vacutug can get an entry for mechanical emptying is not possible. In this slum, 5 community septic tank is built in 2015 and the size of the septic tank is large, so it has not required emptying till now. The average cost for manual emptying process and mechanical emptying process is found approximately 700 BDT. Safety issues

during the emptying operation are almost neglected. During manual emptying, sweepers do not wear the safety protective gear i.e.; dress, gloves, gumboot, mask etc.

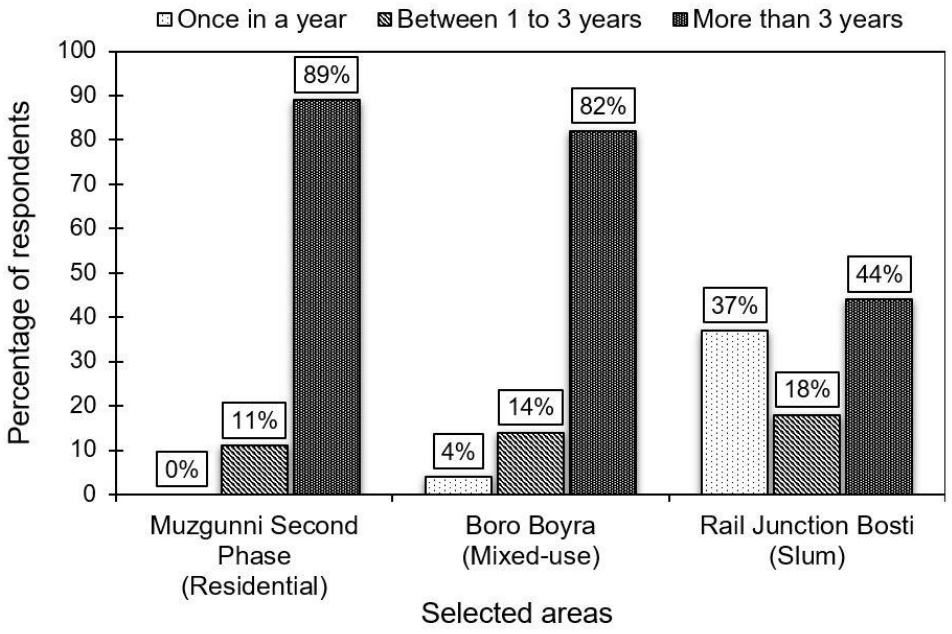

Figure 9: Emptying frequency of containment at the study areas

Figure 9 describes the containment emptying frequency of the study area. Emptying frequency of containment has been categorized into three types i.e. more than 3 years, equal or less than 3 years and at least once in a year. At residential area, total 26 respondents have emptied their septic tank and 19 respondents have emptied twice or more times and only 7 respondents have emptied once. In this 19 respondents, 17 of them that means 89% respondents have emptied their septic tank by 3 years or more and rest of them have emptied their septic tank by less than 3 years as shown in figure 9. But no septic tank is emptied once in a year which has been stated in Bangladesh National Building Code (BNBC) in the residential area.

Again, at the mixed-use area, about 82% of respondents have emptied their containment by 3 years or more and 14% of respondents have emptied their containment by less than 3 years. But only 4% of respondents have emptied the containment once in a year. Similarly, at the slum area, 44% of respondents emptied their containment by 3 years or more and 18% emptied their containment by less than 3 years. But 37% of respondents have emptied the containment once in a year. The respondents who emptied their containment once in a year is pit latrine and the number of the user against this pit is more, for that reason, emptying frequency decreased.

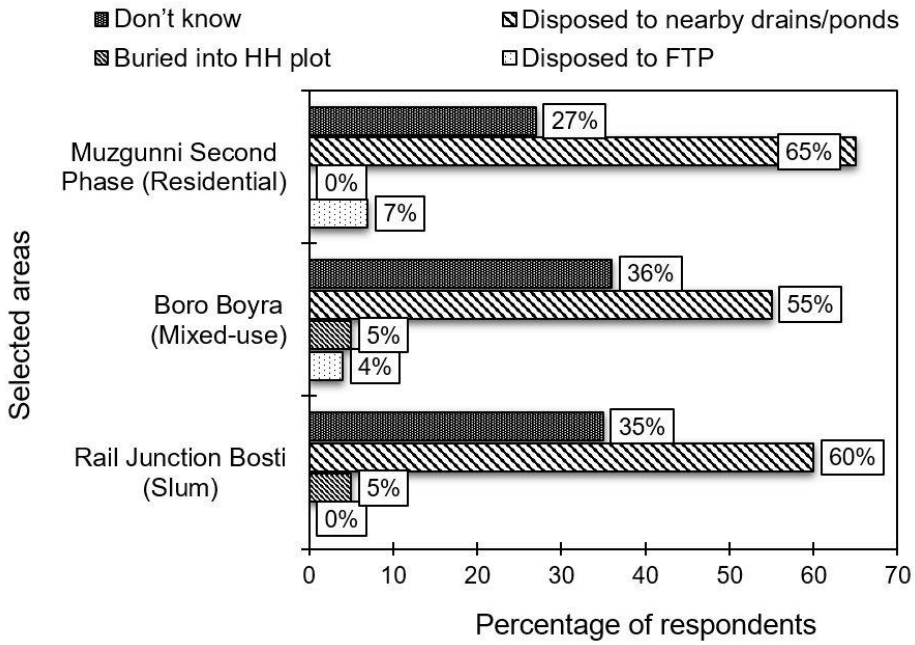

Figure 10: Sludge disposal at the study areas

Figure 10 describes the sludge disposal facilities of the study area. At residential area, it is seen that about 65% of emptied sludge is disposed to nearby drains or stagnant water body or rivers which is harmful for the surrounding environment where only 7% of emptied sludge is disposed to faecal sludge treatment plant (FTP). A big portion of respondents nearly 27% do not know where the emptied sludge finally being disposed. On the other side, at mixed-use area, about 55% of emptied sludge is disposed to nearby drains where only 4% of emptied sludge disposed to FTP. Similarly, at slum, 35% of respondents have not any idea about the sludge disposal, 60% of respondents septic tank connected to drains or ponds or other water body. 5% of sludge buried into the household plot at both the Boro Boyra and Rail Junction Bosti area. By KCC, previously the emptied sludge had being disposed to the KCC solid waste dumping trench ground at Rajbondh 2 if emptying operation is done by the KCC or CDC emptiers .But presently a new FTP has been constructed beside the solid waste dumping site and sludge is being dumping there currently.

4. CONCLUSIONS

Faecal sludge management has now a trending and valuable options to protect the environment.

- Septic tanks are dominant as containment in both at the residential area and the mixed-use area where pit latrines are dominant in the slum. In containment size suitability, 81% of containment are suitable at the residential area where this value was 75% and 30% respectively for the mixed-use and slum area. Most of the containment are suitable in all three areas except slum area where 29% of containment are not suitable. Most of the septic tank at all three area is connected to the nearby the roadside drains or ponds or stagnant water body where only 7% and 4% of containment had soak well for purification.
- Most of the containment overall current condition is in good condition except only the slum. Highest 77% of containments condition is good in the residential area where 26% containment at the slum is in poor condition. In containment accessibility, two contrary things are available where 77% of containment are accessible at residential area, on the other side 78% of containment is not totally accessible for emptying operation at the slum.

- About 31% of the septic tank has been emptied by manually where only 13% is mechanically in the residential area. However, for the mixed-use area, manual emptying is about 50% and mechanical emptying is about 7% where all emptying operations have been done either manually or self.
- In all three areas, most of the containment is not emptied yet and a small number of containment have been emptied once. There is lack of knowledge among the people about the mechanical emptying. For this reason, private sweepers are dominantly doing the emptying job by the rudimental way. All the emptiers both manual and mechanical, ignore the safety issues during emptying operations.
- In the sludge disposal section, most of the sludge disposed to nearby sewerage drains, ponds, stagnant water body or river and the value is 65%, 55% and 60% times of emptied sludge disposed to that place which is harmful to the surrounding environment. Presently a new faecal sludge treatment plant (FTP) is constructed beside the solid waste dumping site and sludge is being dumped there.

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