

A Comparative study of mechanical dewatering and natural drying process of fecal sludge in urban context

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ABSTRACT

The aim of the study is to explore dewatering technologies in Fecal sludge treatment. For Dewatering of Fecal sludge, shortlisted technologies are developed in the decision matrix tool. The criteria for shortlisting are current technologies implemented for FSM in Bangladesh. From literature review, interview of sanitation experts on technologies used and applicable. The treatment modules in FSM can be categorized as nature based and mechanical. Nature based treatment modules are natural biological process requiring very low or no energy input with low operations and maintenance, but it requires larger land areas. Mechanical treatment modules require external energy with higher operations and maintenance, but it requires lesser land area. The tools used in this study, enables better understanding of the FS treatment challenges and identify appropriate operational solutions need to evolve with the changing FS treatment landscape.

INTRODUCTION

FSM is now an acute issue in rural and urban areas of Bangladesh. Basic sanitation coverage is 64%, safely managed sanitation is currently 36.4% in rural areas. (MICS, 2019). 58% urban residents are using improved sanitation systems, but sludge and waste from those latrines are polluting the environment. Bangladesh has reached to her goal of improved sanitation and mostly completed the Millennium Development Goal (MDG)-7 by 2015 (JMP, 2015). The country has also 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). In Bangladesh, 46 million urban inhabitants, more than 80% use on-site sanitation (UNICEF, 2015). Bangladesh has 522 urban centers accounting for 29% (44 Million) of the national population. Thus, we are on the edge of another "sanitation revolution" to manage the human excreta (Islam, 2016). As we approach 2030, rapid progress is required to meet the sustainable development goal (SDG) of universal safely managed sanitation', which includes better sanitation facilities that are not shared with other households, and where excreta are safely disposed of in situ or removed and treated off-site (JMP 2018). One of the most challenging treatment mechanisms in FSM is dewatering. Dewatering is also necessary prior to resource recovery applications (Linda et al. 2014). In the urban areas there is typically no managerial system for FS and they frequently discharge untreated sludge into the open drains, water bodies, farmland, etc, which creates a huge burden on public and environmental health. Thus, setting up frameworks, creating sustainable business models, capacity development followed by appropriate efficient treatment technologies and mechanism along with integrated planning methodologies needs to be adopted.

METHODOLOGY

The purpose of this work is to assess the existing situation of sludge generation and also the effective management of sustainable treatment process by examining the applicable method for the city. The study was limited in scope to Tarabo, a city just besides Dhaka the capital of Bangladesh. The scope of the study

focused on an integrated management by all stakeholders in the provision and management of FS in Tarabo City.

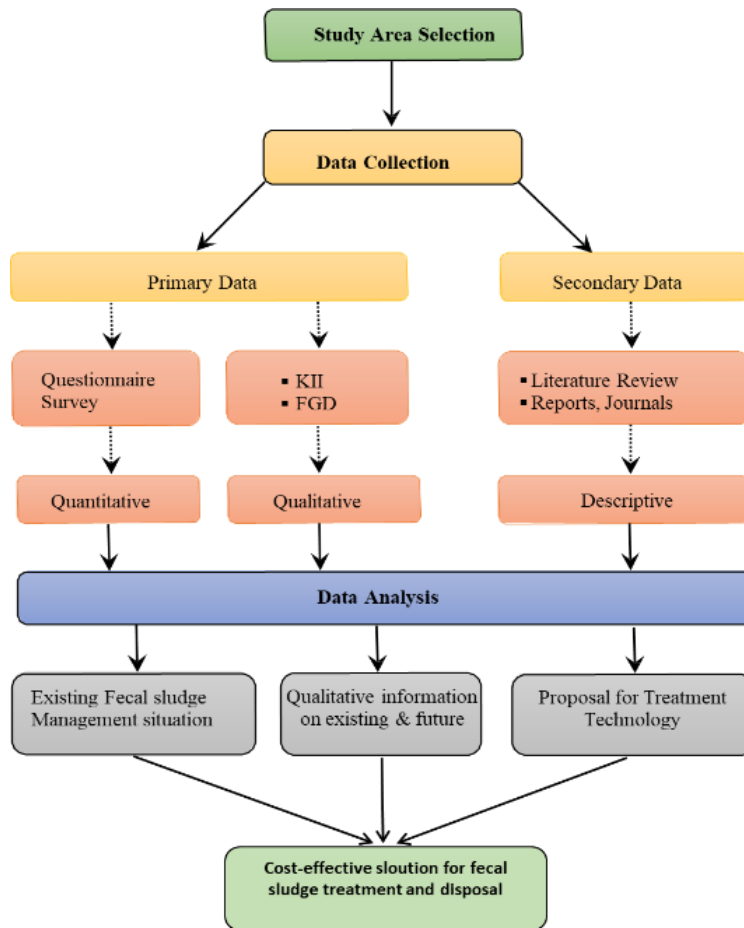


Figure 1 Typical steps adopted in this research

The research has been conducted as mix method research. Because both types of data that mean qualitative and quantitative data have been collected and analyzed in this research. Qualitative data have been gathered from several Key Informant Interviews (KII) from the stakeholders of Pourashava and Group Discussion (FGD) to the empties. Quantitative data have been collected by a series of household surveys by preparing a questionnaire in the study area. The questionnaire has been prepared based on the indicator. The objective wise data collection and methodology adopted has been shown in Table.

Table 1 Research objectives and methodology matrix

Objectives	Data collection and analysis methods	To
1. To identify the existing fecal sludge management process in the study area.	Visual inspections and observations of containment facilities	
2. To identify the quantity of sludge fecal sludge generated in the study area.	Quantitative analysis by questionnaire survey KII to Tarabo pourashava and Local Dphe.	
3. To find out the problems related to treatment of fecal sludge and to propose a respective probable solution considering both mechanical and natural drying.	Qualitative analysis from KII, FGD with pourashava stakeholders Quantitative analysis by questionnaire survey	
4. To develop decision matrix for faecal sludge dewatering technology	KII, FGD with prourashava stakeholders and manual& mechanical emptiers	
5. To identify technical and economic efficiency of mechanical and natural fecal treatment processes.		

assess the fecal sludge volume and treatment technology, a questionnaire survey has been conducted based on some indicators of containment, emptying and knowledge, and perceptions of users in the study area. The questionnaire has been prepared in such a way that this will provide an overall scenario on towns' existing sanitation condition. The questionnaire target is the house owner who can give extensive information about the containment. During the survey, observations have also been made to match the respondent answer and real-world scenarios. Then the answers are validated. Each indicator has several parameters, and each variable consists of some indicators.

KEY FINDINGS

In Tarabo, 97.03% of its population has access to individual toilets and 2.97% uses others toilet. Among the surveyed existing toilets, about 3% of the toilets are reported damaged or flooded. The type of toilet in use and water usage pattern also has an influence in the amount and type of faecal sludge that is being generated in the city. The most common toilet type in Tarabo is squat toilets which is being used by 93% of the population, while only 7% use flush toilets. Both toilet types are water sealed. The remaining 4.64% have slab toilets with a hole. Most of the users use 1-2 liters of water while using the toilet and some might require 2-4 liters of water. The people who do not have toilet in their households (2.97%) are mostly due to financial problems to construct a toilet. A few of them have no space to construct a toilet. The people who require improvement of the toilet but are not able to improve it, most of them mentioned financial constraints not to do so. Currently there is no faecal sludge treatment system in Tarabo. The emptied sludge from containment is disposed in nearby places without any treatment. Sometimes the emptier disposes the collected sludge into a dug hole. The Paurashava has 1.0 acre of land for the construction of FS and MSW treatment plant. A focus group discussion with manual pit emptiers was organized to gather their views and opinions regarding the emptying services they are providing, the dangers and risks associated with the profession, and upgrading to mechanical pit emptying services. A focus group discussion was organized with the Conservancy Section of Tarabo Paurashava to understand the FSM services currently being provided, difficulties and challenges being faced, and requirements for future expansion of FSM services throughout the Paurashava. The significant findings of the FGD are summarized below.

- The conservancy department has lack of workforce
- There are currently 2 vacuum tankers in the Paurashava
- Paurashava has the database of manual pit emptiers but Paurashava doesn't provide any formal license to them for emptying service;
- Paurashava doesn't collect any sanitation tax,

Table 2 Summary of Sanitation situation in Tarabo Paurasha

Items	Key Findings	Mitigation Measures
SERVICE CHAIN		
User interface	97.03% households have their own toilets 2.97% HHs have no toilet, of which 2.97% are poor and 0% are non-poor	Community mobilization, sensitization and awareness building Building linkage with MFIs for soft loan Subsidy to poor HHs
Containment	35.40% households have no containment. 61.63 HHs have containment (44.31% septic tank, 7.67% single pit, 8.91% Dug Hole and 0.74% double pit). 38.37% of containments (septic tank, single pit, Dug Hole and double pit) are not functional where 30.45% are non-poor and 7.92% are poor.	Capacity building of Mason and sanitation enterprise Community mobilization, sensitization and awareness building Building linkage with MFIs for soft loan Subsidy to poor HHs Enforce regulations and BNBC Code.
Emptying and Transportation	Out of 61.63% of the containment systems, 27.30% of the containment units had been desludged while remaining 72.70% had never been desludged No formal emptiers and emptying is done by informal emptier (sweeper) 7% HHs are accessible by 3m3 size vacuum tanker, and 36% HHs are accessible by 2 m3 size vacuum tanker. Majority HHs 35% are accessible by tri-wheeler (van).	Community awareness building Private sector engagement to provide FSM service Market promotion Institutional strengthening Capacity building
Treatment, disposal or re-use	No treatment plant 30% of emptied sludge disposed in dug hole and 54% in the drains or waterbodies 1.0 acre land available for the construction of treatment plant	Construction of sustainable FSTP Engage private sector for treatment plant operation Explore opportunities for end-use in agriculture, recycling, energy recovery, etc.
Perception and Willingness	45% HHs have willingness to invest for improvement of their containments. 47% HHs have shown interest to invest for desludging	Community mobilization, sensitization and awareness building Market promotion for sanitation service

Shit-flow Diagram

Shit flow diagram is a tool generated diagram of faecal flow in the Paurashava. It is readily understandable and communicable mapping of where the faecal sludge is not managed while moving from defecation to disposal or end-use. Second method is by assessing the actual situation of sanitation value chain to understand the reasons behind the observed faecal flow in the Paurashava.

The SDF Graphic Generator tool was used to generate the diagram using the field survey data. SFD for Tarabo shows that about 97% of the generated faecal sludge is unmanaged while only 3% of the sludge is safely managed. It is a clear visual representation of the dire situation of faecal sludge situation in Tarabo which requires immediate and prompt management solutions, shown in in following figure.

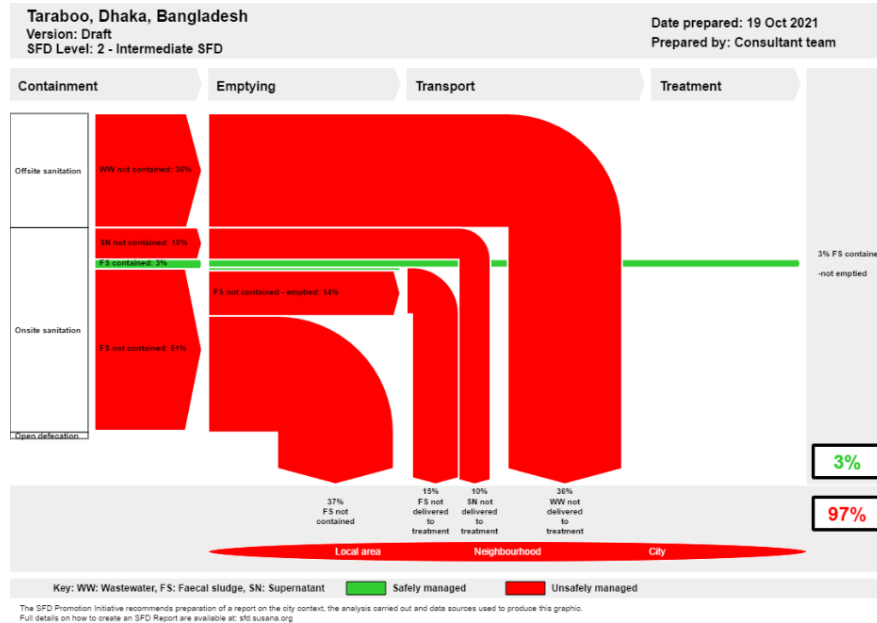


Figure 2 Sanitation value chain assessment

Estimation of Current Demand for Faecal Sludge Emptying

It is estimated from the HH survey that out of 67,059 HHs, only 15,739 (23.47%) Households have experience of asking a pit/septic tank emptying service for their households within last 5-years. It is estimated that for Double Pits and Septic Tank would be in average of 3 m³ containment while single pits are considered 1.5 m³. In the below table the volume of faecal sludge estimation is provided where yearly estimated sludge volume is **35416** m³ /year or 97.03m³ / day.

Table 3 Estimated Volume of Sludge Emptied in Each Year (Current Demand)

Types of Containment	Estimated Number of Service Requests/ Year	Estimated Volume Per Containment (m ³)	Total Estimated Volume (m ³) / year
Double pit	285	3	855
Septic tank	10752	3	32255
Single pit	1537	1.5	2305
Total	12574		35416

The above approach of estimating the sludge generation is based on emptying demand and volume estimation method. There is another method which is called the sludge accumulation method. Table 3 shows the volume of FS estimations as per sludge accumulation rate and for the design period from 2023 to 2030, the volume projected is 27.56 m³/day to 35.22 m³/day.

Table 4 FS generation as per sludge accumulation rate

Item	Unit	2023	2026	2028	2030
Population		251,470	281,187	301,505	321,424
Sludge Accumulation	cum/year	10,059	11,247	12,060	12,857
Sludge Accumulation	cum/day	27.56	30.81	33.04	35.22

Sludge accumulation rate 0.04 m³/capita/year*, Source: BNBC Sec 6.9.12.10

Based on the 3 and 4 tables reliable faecal sludge volume is estimated to be 97 m³/day. These diverse situations undoubtedly highlight how crucial it is to determine the true volume of faecal waste and the genuine demand for services before making any investments in selection of treatment technology.

RESULTS

Decision Matrix for Selecting Sanitation Technology in an urban area is dependent on the local conditions and end user requirements. Since sanitation is the responsibility of local governments, additional issues of funds, skills, and capacities play a vital role in selecting technology so as to ensure sustainability of the investment.

Parameters for selecting sanitation technology are based on World Bank's Water and Sanitation Program in 2008 listed out a number of parameters in selection of suitable sanitation technology. Using this framework, we have further adapted and developed different parameters that play a critical role in selecting sanitation technology.

The parameters listed in the figure 3 and their role in selection of sanitation technology is as described below:

Cultural acceptability: A technology can have local cultural implications and hence non-acceptance by local communities will result in user avoiding usage of the technology. For example, it is a significant cultural shift, and hence a challenge to replace pour flush toilets with dry toilets despite the many benefits of the latter.

Affordability: Availability of funds are key for investment and operating the investment. High capital and operation costs are generally a deterrent especially when using scarce precious financial resources of local government for adoption of any technology. Similarly, households are extremely price conscious in making decision for investing in on-site containment technologies.

Operation and maintenance requirements: Any technology requires periodic maintenance and treatment facilities need labor, energy and other consumables to operate the facility. Any system that requires complex O&M leads to higher costs and is not easily accepted by users and government authorities.

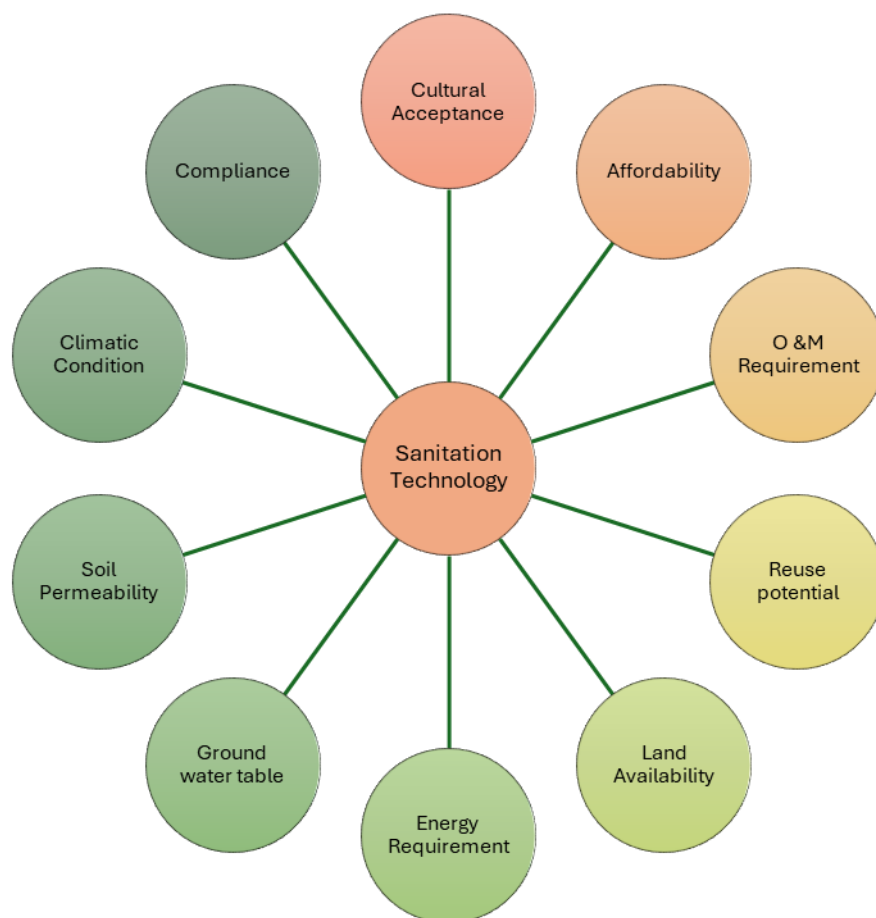


Figure 3 Parameters for selecting sanitation technology

Land availability: In cities land is always a scarce resource and for setting up treatment facility available land area determines the choice of technology. In case of houses, availability of land can be an issue in implementing a specific containment system.

Energy requirements: In developing countries operations of most treatment plants fail due to intermittent power supply or high operation and maintenance cost for operating energy intensive equipment. A technology that does not require any power or has very low energy requirements is suitable.

Ease of implementing Reuse: Reuse of treated waste is critical for ensuring environment sustainability. Waste has resource of water, nutrient and energy which can be recovered to produce variety of products. Further reuse can generate additional revenue to recover the operating cost of the technology. In implementing reuse, cultural acceptance of reuse product made from waste should be considered along with government regulations.

Ground water table: High ground water table affects the construction as well as day-to-day operations of sanitation system. To ensure safety of ground water from pollution, appropriate sanitation technology should be selected.

Soil Permeability: Most on-site containment systems require soakage of water. Soil with poor permeability can severely affect the operation of the technology (e.g., twin pits) and hence in such geographical conditions appropriate technology (e.g., modified twin pit) needs to be selected.

Climatic conditions: In considering sanitation technologies, the local climate should be considered. Temperature, rainfall pattern, frequency and intensity of floods and cyclonic storms influence the operations of technologies and its efficacy in delivering required results.

Compliance: Any sanitation technology selected must comply with local regulations such as building bylaws, environmental laws and social norms.

For Dewatering of Fecal sludge, the following technologies are listed. The technologies mentioned here are assessed to be further shortlisted to develop the decision matrix. The criteria for shortlisting are current technologies implemented for FSM in Bangladesh from literature review and interview of sanitation experts with working experience in Bangladesh and country-based experts on technologies used and applicable.

- ❖ Trenching
- ❖ Pond Systems
- ❖ Planted Drying beds
- ❖ Unplanted Drying beds
- ❖ Semi mechanical FSTP
- ❖ Fully mechanical FSTP
- ❖ Geobags
- ❖ UASB
- ❖ Omni processor
- ❖ Thermal treatment
- ❖ Co-treatment

The treatment modules in FSM can be categorized into nature based and mechanical. Nature based treatment modules are natural biological processes requiring very low or no energy input with low operations and maintenance but they require larger land areas. Mechanical treatment modules require external energy with higher operations and maintenance but they require lesser land area. Trenching as a permanent solution for faecal sludge treatment is ruled out because this can contaminate ground and surface water. Planted drying beds, unplanted drying beds and Mechanical FSTP's are most suitable solutions for cities in Bangladesh. The nature based and mechanical treatment modules used are for solid-liquid separation, treatment of liquid and treatment of solids. Both nature based and mechanical treatment modules work in a certain combination to treat the faecal sludge to required regulatory norms. One can also combine the mechanical and nature-based treatment modules in combination to achieve the desired treatment results. Trenching will not be applicable as the daily faecal sludge generation is close to 100 m³ /day in Tarabo Pourashava.

Town Specific Technology selection

The treatment processes that are most applicable to Tarabo's context are:

- **Unplanted Drying Bed** for solid-liquid separation and liquid treatment by anaerobic baffle reactor and planted gravel filter. Solids can be treated through composting process. This is already in use in Bangladesh at Shakhipur and Kushtia.
- **Planted drying bed** for solid-liquid separation followed by planted gravel filter for further treatment of liquid. The solids deposited on the planted drying bed are to be collected after 2-3 years and can be treated through composting process, e.g., Khulna.

- **Screw Press** for solid-liquid separation followed by liquid treatment in different mechanical treatment modules such as moving-bed biofilm reactor, membrane bioreactor, sequential batch reactor and omni processor. Solids can be treated through thermal process or disposed in landfills.

Table 5 Suitable technologies in Tarabo Pourashava

Type	Technology	Advantages	Disadvantages
Planted Drying Beds	Technology is robust and flexible for extreme conditions. No direct human contact is required.	Minimum operation and maintenance required. Desludging of beds can be done every two to three years. Produces a small amount of stable sludge which can be used as soil conditioner.	Relatively large space required. Regular plant maintenance is required.
Unplanted Drying beds	Gravity-based inflow and gravity-based out flow of leachate. Manual/ mechanical removal of dewatered sludge, minimum exposure to operational staff.	Effective technique for liquid/solid separation. Low-capital investment. Low operation and maintenance cost	Relatively large space required. Regular operation & maintenance
Mechanical treatment	Simple design and continuous operation. Excellent capture rate. Designed to feed material that has a 40-60% water make up.	Modular and scalable. Land requirement is low. Can deal with varying sludge loads. Capture rate is high .	Maintenance is hectic. Polymer is required for thickening. Relatively higher energy requirement. Require highly skilled staff for operations. Not a end-to-end solution.

The first two processes described are nature-based treatment process and the last one is a mechanical treatment process. A Technology Matrix is prepared considering potential technologies. For each type of technology, Capex, Opex and lifecycle cost is calculated, considering the FS generation rate, existing facilities, land requirement and reuse potential.

Cost Comparisons of Nature based and Mechanical process

Treated sludge is more hygienic in nature and has an improved structure, so it has more market value. The practical implementation of any technology depends on its techno-economic viability. Usage of thickening and dewatering technologies produces denser sludge with approximately 32% dry solid concentration, while drying technologies produce sludge with more than 62% dry solid concentration (Flaga, 2005). The solid retention for the thickening and dewatering technologies like mechanical screw press captures solids more than 90%, and, hence, these can generate more revenue. Sludge for use in agricultural purposes is always preferred to have a solid concentration of more than 60%. Dewatered sludge still contains a significant amount of water often as much as 70 percent but, even with that moisture content, sludge no longer behaves as a liquid and can be handled as a solid material. Sludge-drying beds provide the simplest method of dewatering. A digested sludge slurry is spread on an open bed of sand and allowed to remain until dry. Drying takes place by a combination of evaporation and gravity drainage through the sand. A piping network built under the sand collects the water, which is pumped back to the head of the plant. After about six weeks of drying, the sludge cake, as it is called, may have a solids content of about 40 percent. It can then be removed from the sand with a pitchfork or a front-end loader. In order to reduce drying time

in wet or cold weather, a glass enclosure may be built over the sand beds. Since a good deal of land area is needed for drying beds, this method of dewatering is commonly used in rural or suburban towns rather than in densely populated cities. Hence, an appropriate combination of dewatering and drying technology could generate better revenue. A detailed financial model was prepared to conduct a cost benefit analysis for different primary dewatering technologies. The financial assessment was performed for a year-long period.

Planted Drying Beds

A planted drying bed is similar to an unplanted drying bed but has the added benefit of transpiration and enhanced sludge treatment due to the plants. The key improvement of the planted bed over unplanted bed is that the filters do not need to be de-sludged after each feeding cycle. Fresh sludge can be directly applied onto the previous layer; the plants and their root systems maintain the porosity of the filter. This technology has the benefit of dewatering and stabilizing the sludge. The beds are filled with sand/soil and gravel to support vegetation. FS is applied to the surface and the filtrate flows down through the subsurface drainage system for further treatment.

Features:

- Consists of an impermeable shallow pit filled with different layers of coarse to fine filter media
- Do not need desludging before each new application
- Sludge need to be removed every 5-10 years

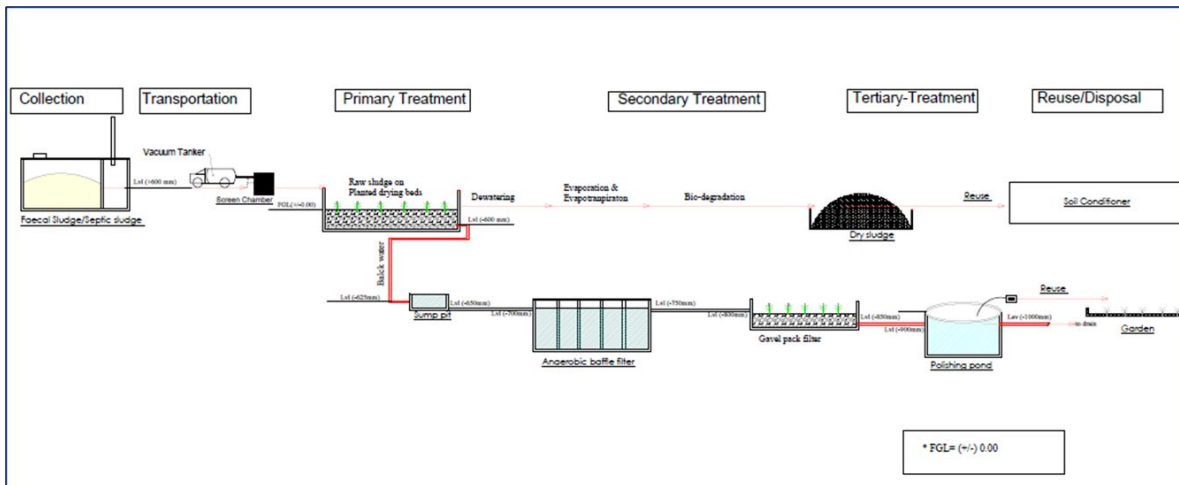
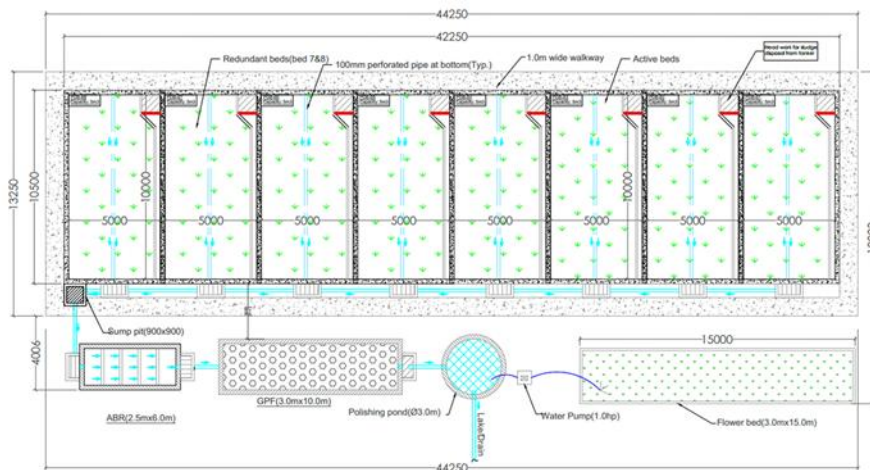


Figure 4 Process flow of Planted drying bed.



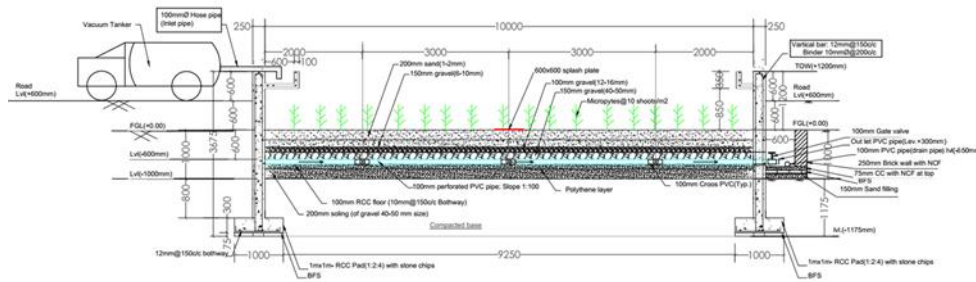


Figure 5 Plan and Section of Planted drying bed.



Figure 6 Planted drying bed in Khulna



Figure 7 Planted drying bed in Jhenaidah

Unplanted drying bed:

An unplanted drying bed is a simple, permeable bed that, when loaded with sludge, collects percolated leachate and allows the sludge to dry by evaporation. Approximately 50 to 80% of the sludge volume drains off as liquid or evaporates. The sludge, however, is not effectively stabilized or sanitized. The final moisture content of the dried sludge after 10 to 15 days of drying should be approximately 60%. After drying, the dried sludge is collected from top of the drying bed for further treatment, end-use or final disposal. The leachate that is collected must be treated properly before disposal. Some features

- Simple sand and gravel filters on which sludge are applied for dewatering
- Drying time is about 10 days
- it is necessary to desludge dried sludge before fresh sludge can be applied
- Dried sludge needs further treatment for pathogen removal if reused.

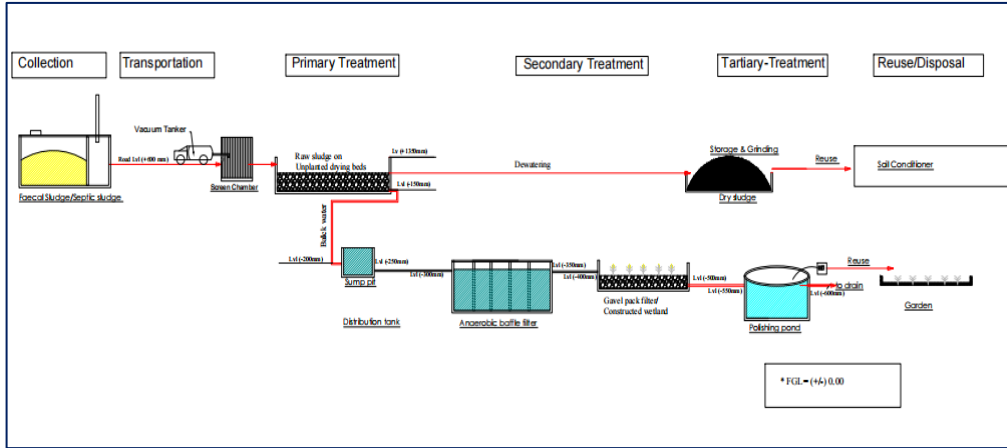
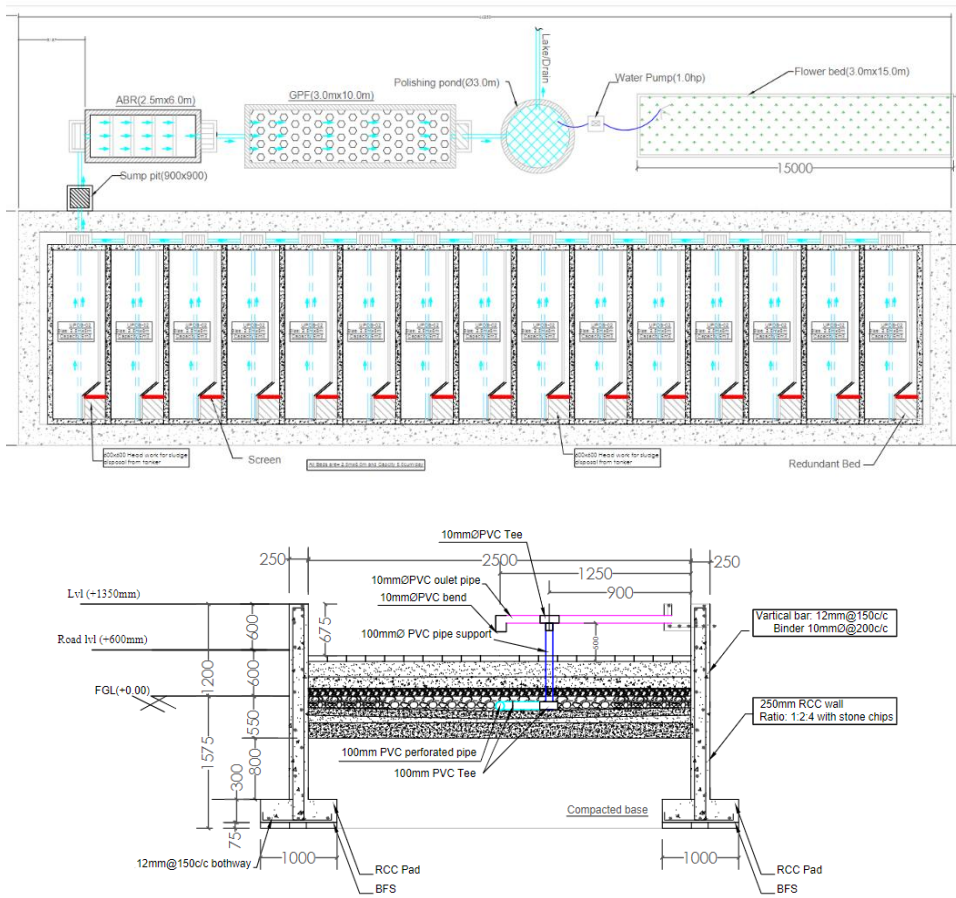


Figure 8 Process flow of Unplanted drying bed.



Detail-A: Unplanted Drying Bed

Figure 9 Plan and Section of Unplanted drying bed.



Figure 10 Unplanted Drying Bed in Chattogram

Mechanical Treatment:

Mechanical dewatering is normally associated with large wastewater treatment plants and is used to separate sludge (residual sludge from wastewater treatment plants or faecal sludge from on-site sanitation) into a liquid and a solid part.

Working principle- Thickening, Dewatering & Self-Cleaning

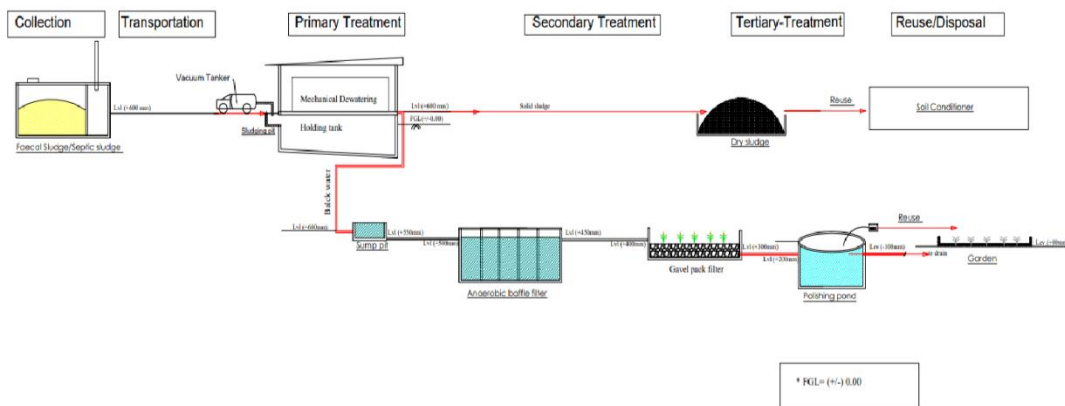
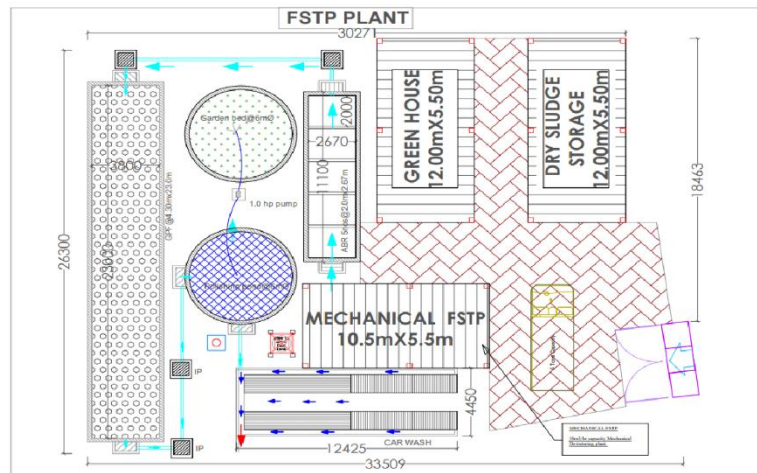


Figure 11 Process flow of mechanical treatment.



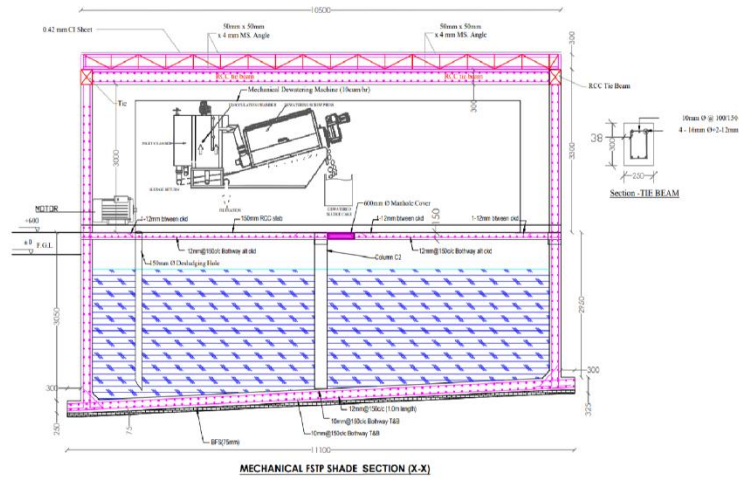


Figure 12 Plan and Section of mechanical treatment plant.



Figure 13 Mechanical Treatment in Mirpur, Dhaka

The above model is small unit used in Mirpur area. Usually, mechanical treatment plant size starts from 8 m³/hr. Which is like 150 m³/day considering 20 hours runtime. In this model financial comparison is done by similar size (100 m³/day) of different treatment technologies. This shows that while nature based treatments (Planted and Unplanted drying bed) are feasible is smaller towns with limited FS generation but as the town's size increases mechanical treatment becomes the predominant technologies for FS dewatering. Selling price for the solid captured is considered to be US\$ 0.01/kg because sludge cake after dewatering process need fatted drying which has a cost implication. Moisture content can be 75%~85%. So, to reduce the moisture content, generated sludge cake to be dried in the greenhouse. Ideas is that through this way the temperature will increase inside the greenhouse which will ultimately kill the pathogen content in sludge cake. The sludge cake will also dry up to reach the desired level of moisture content. Then this will be used in subsequent co-composting system to make it compost for the use of agriculture purpose as fertilizer. so the cost of manure would come to around US\$ 0.1/kg. As evident from the above table all the dewatering mechanisms generate negative revenue. To have a sustainable FSTP operation, the maintenance costs need to be subsidized from sanitation tax, FS collection fees and MSW compost sells.

Table 6 Summary of Dewatering technologies in context of Capex, Opex, Revenue.

Treatment Technology	Capex US\$/m ³	Opex US\$/100m ³ /year	Revenue US\$/100 m ³ /year	Net Profit US\$/100 m ³ /year
Planted Drying bed	\$8,213	5528.0	789.5	-4738.5

Unplanted drying bed	\$10,950	12728.0	4605.4	-8122.6
Mechanical FSTP	\$4,347	16197.0	11842.4	-4354.6

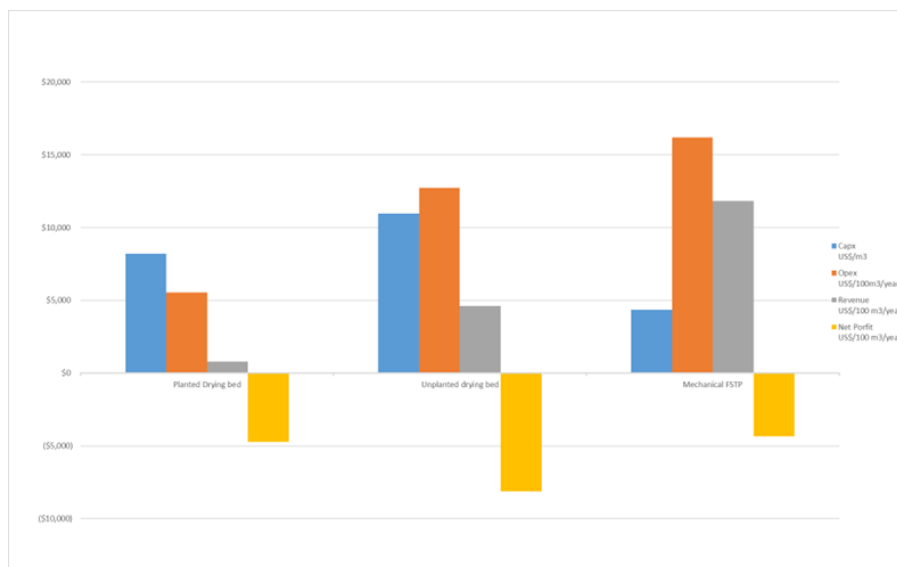


Figure 14 Financial comparison of dewatering technologies

Multicriteria analysis of Dewatering technologies

Regarding treatment and disposal of emptied fecal sludge, the following important points/issues were identified in this study:

- The total population of Tarabo is expected to increase to around 3,21,424 by 2030 (from the current population of about 2,51,470 in 2023). This will result in significant increase in demand/need for FSM services by 2030.
- Municipality has procured 1.0 acres land for the construction of treatment plant.

The treatment plants (FSTPs) should be designed and constructed based on the outcome of thorough these studies focusing on detailed assessment of treatment options including mechanical solid-liquid separation, planted/unplanted drying beds, etc. For liquid treatment, and options for processing of treatment products (e.g., dried sludge), giving emphasis on resource/energy recover options (e.g., co-composting, briquettes and other energy recovery options). Appropriate treatment and disposal (satisfying national discharge standards) of effluent should also be given due consideration. The required FS treatment capacity has been estimated considering complete coverage of FSM services throughout the city but excluding the household using alternate twin pit toilets. Tarabo is a IC class towns with a design population **above 0.30 million in 2045**, as this is an urbanized town with many industries and handicrafts. The peak FS treatment (and desludging) demand after implementation of the sanitation improvement plan has been estimated at about **103 m³/day**. In this study, the dewatering technology selection matrix for solid-liquid separation is finalized considering social & technical aspects among others with the help of a developed tool. The developed Dewatering technology selection matrix is provided in the following table. The assessment was relevant since it will be able to utilize this tool, which can be used to select FS dewatering technology in all size of towns. This multicriteria decision matrix will aid decisionmakers and sanitation workers to select dewatering technology in a structured manner.

Table 10 Dewatering technology selection matrix

Dewatering technology selection matrix					
Criteria	UPD+ABR+PGF	PDB+PGF	Mechanical: screw press+ liquid treatment	Preferred technology	Comments
Financial Factor					
Land Requirement	High	High	Low	screw press+ liquid treatment	1.0 acre land is available for for FSM and SWM. With Low requirement of land screw press+ liquid treatment will be a good fit.
CAPEX	Medium	Low	High		CAPEX will be High for this case.
OPEX	Low	Low	High		Opex would be sustainable by raising sanitation tax and selling of compost
Institutional Factor					
Operator's skill	Medium	Low	High	screw press+ liquid treatment	It is suggested to have medium to high requirement for skilled operator
Management team	Low	Low	High		It is suggested to have medium to number management team
Climate Factor					
Effect of temp. change	High	Moderate	Low	screw press+ liquid treatment	Although our chosen technology has an adverse effect on Climate but with certain mitigation steps it can be overcome
Effect of Rain	High	High	Low		
Effect of low sunlight	High	High	Low		
Social Factor					
Degree of Odor	Medium	Low	Low	screw press+ liquid treatment	This was a major concern at local level which need to be taken care of.
Noise production	Low	Low	Medium		Our chosen technology has some effect on noise production
Aesthetic of plant	Good	Better	Good		Aesthetic view will be good
Technical Factor					
Technical Complexity	Moderate	Low	High	screw press+ liquid treatment	This system would be technically complex due to polymer dosing.
Use of Natural Force	High	High	Moderate		The technology uses electricity
Effect of power cut	Low	Low	High		this system has a big impact of power cut.
Coping with Variable Flow	High	Low	High		It is good to have a system which Has a high capacity of coping with variable flow
Consistent effluent quality	Moderate	Good	Moderate		This is same for all three technologies.
Ease of making Reuse products from Sludge	High	Moderate	High		More sludge is available from screw press.

CONCLUSION

This study comprised a rapid assessment of the status of FSM in an urban town with Rapid urbanization and population growth generating huge amounts of FS.

- About 6 % of the HH have toilets that are damaged or unavailable.
- Around 20% of the containers are functional but does not have a proper outlet.
- No formal empires and emptying is done by informal emptier (sweeper)
- There is no treatment or disposal service in the city but city authorities have accrued 1.0 Acre of land outside city core area.
- Around half of the population should interest to invest in containment improvement and using desludging services.
- The estimated demand for Fecal sludge is around 100 m³/day.
- Comparing FS treatment technologies applicable in local urban context.
- Suitable dewatering of fecal sludge using Planted or Unplanted drying beds and Mechanical screw press.
- Cost Comparisons of Nature based and Mechanical process to find mechanical dewatering to be most cost-effective solution in this urban context.
- Developing a dewatering technology selection matrix to aid decisionmakers and sanitation workers to select dewatering technology in a structured manner.

RECOMMENDATIONS

The following recommendations are suggested.

- The study has been conducted in small urban pourashavas. Further study can be conducted on rural and urban areas as well as the City Corporations.
- There are 17 indicators that have been considered to formulate the multicriteria analysis tool. More indicators can be adopted for more accurate results.

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