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Measuring Levels of End-Users' Acceptance and Use of UDDT

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Abstract

This study focuses on a new improvement for the success of ecological sanitation project by using urine diverting dehydrating toilets (UDDTs). This concept links human waste to food security, recognizing the value of treated human waste for fertilizer. This shows that the UDDT is an efficient way to prevent the mixing of urine and feces by providing an area for these separate waste products to be treated. The level of acceptance toward UDDTs concept is acceptable to the people in San Fernando, La Union since they have no existing sewer and drainage system especially on the area of the bay side residents.

Keywords: *Construction materials, ecosan, ecological sanitation, recycling waste, uddt*

1. Introduction

Today, billions of people in urban as well in rural areas have no proper sanitation. Approximately 6000 children die every day from diarrhoeal diseases related to inadequate sanitation and hygiene. About 1 billion people worldwide, mostly children are infected with worms and as a result suffer nutritional deficiencies and poor growth. Both of these groups or diseases are transmitted through human faeces in the environment. Many areas are suffering from chronic fresh water shortages and the demand for freshwater has tripled in the past 50 years. By 2017, more than half the world's population will face a shortage of water.

Sewage discharges from centralized, water- borne collection systems are a major component of water pollution all over the world. Only about 300 million people in the world today have end of pipe treatment of sewage to a secondary level before the sewage is discharged into open bodies of water. Pollutants also leak into groundwater from sewers, septic tanks, pit toilets and cesspools.

The sanitation practices promoted today are either based on hiding human excreta in deep pits or on flushing them away and diluting them in rivers, lakes and the sea. Drop and store systems can be simple and have many drawbacks. Often they cannot be used at all in crowded areas, on rocky ground where the groundwater level is high or in areas periodically flooded. They require access to open ground and the digging of new pits every few years [1].

Flush and discharge systems require large amounts of water for flushing, and for many municipalities unaffordable investment in pipe networks and treatment plants. Over a year for each person some 400-500 litres of urine and 50 litres of faeces are flushed away with 15,000 litres of pure water. Water from bath, kitchen and laundry may add up to another 15,000-30,000 litres for each person. Further down the pipe rainwater from streets and rooftops and waste water from industries are often added,

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Thus at each step in the flush and discharge process the problem is magnified: the really dangerous component, the 50 litres of faeces, is allowed to contaminate not only the relatively harmless urine but also the huge amount of pure water used for flushing and an equal or even larger amount of grey water.

The response to the problem is ecological sanitation which is based on three fundamental principles; preventing pollution rather than attempting to control it after people pollute; sanitizing the urine and the faeces; and using the safe products for agricultural purposes. This approach can be characterized as sanitize and recycle.

This approach is a cycle- a sustainable, closed loop system shown in Figure 1. It treats human excreta as a resource. Urine and faeces are stored and processed on site and then, if necessary, further processed off site until they are free of disease organisms. The nutrients contained in the excreta are then recycled by using them in agriculture.

Figure 1. Ecological Sanitation Closed Loop System [2,24]

As essential part of EcoSan is to contain and sanitize human excreta before they are recovered and reused. Human faeces, rather than urine, are responsible for most diseases spread by human excreta. Thus, a dehydration and decomposition are methods needed to sanitize faeces. Dehydration or drying, of faeces is easier if they are not first mixed with urine and water. When faeces decompose, the pathogens in them die and are broken down. Thus, with either method, viruses, bacteria and worm eggs are destroyed. It is only then that faeces can be recycled. Urine is usually safe enough to be used in agriculture without further treatment, either directly or after a short period of storage.

The challenge of using UDDT lies on the extraction of relevant and useful information that may be taken from vast materials, may they be printed or otherwise. Basic and traditional statistics are acceptable for analysis. However, more advanced methods of simplification or reduction of data set, and still preserving its important features are needed for a more accurate assessment of the dynamic process involved.

The study is primarily on levels of end-users' acceptance of ecological sanitation project by using urine diverting dehydrating toilets (UDDTs) based in San Fernando, La Union setting.

Filipino engineers especially those in the government sector have been trying to find various ways on how to improve the sanitation practice of Filipino people. Various complain in the locality such as sewer system, water supply and cost of the installation of sanitation facility. This factor has played a very vital role in making it hard for the government health officers to fully implement the right sanitation practice.

2. Literature Review

Ecological Sanitation (EcoSan) is an environment friendly sustainable sanitation system which regards human waste as resource for agricultural purposes and food security. In contrast to the common practice of linear waste management which views waste or excreta as something that needs to be disposed, EcoSan seeks to close the loop of nutrients cycle, conserve water and our surrounding environment.

The basic principle of EcoSan is to close the loop between sanitation and agriculture without compromising health and is based on the following three fundamental principles: (a) Preventing pollution rather than attempting to control it after people pollute; (b) Sanitizing the urine and faeces; and (c) Using the safe products for agricultural purposes.

The goal of closing the nutrient and water cycles is need to be fulfilled on a large scale to render current sanitation practices an eco-friendly one. However, it is generally agreed that it is wise to reuse nutrients and save resources. The EcoSan toilet technology fulfils this aim and provides effective alternative solutions, with or without water, because this technology can be viewed as a three step process dealing with human excreta i.e. containment, sanitization (treatment) and recycling.

2.1. History of Ecological Sanitation

Ecological sanitation or EcoSan is an ancient idea that has gained new credence internationally. People throughout history have used faeces and urine for agricultural purposes as they have recognized the positive qualities of these so-called wastes. EcoSan builds on this knowledge, and promotes a range of technological sanitation that allows people to hygienically recycle human excreta back into the environment.

The recovery and use of urine and feces in "dry sanitation systems", *i.e.*, without sewers or without mixing substantial amounts of water with the excreta, has been practiced by almost all cultures. The reuse was not limited to agricultural production. The Romans, for example, were aware of the bleaching attribute of the ammonia within urine and used it to whiten clothing [3, 6, 15].

Many traditional agricultural societies recognized the value of human waste for soil fertility and practiced the "dry" collection and reuse of excreta. This enabled them to live in communities in which nutrients and organic matter contained in excreta were returned to the soil. Historical descriptions about these practices are sparse, but it is known that excreta reuse was practiced widely in Asia (for example in China, Japan, Vietnam, Cambodia, Korea) but also in Central and South America. However, the most renowned example of the organized collection and use of human excreta to support food production is that of China [4, 7, 25]. The value of “night soil” as a fertilizer was recognized with well-developed systems in place to enable the collection of excreta from cities and its transportation to fields. The Chinese were aware of the benefits of using excreta in crop production more than 2500 years ago, enabling them to sustain more people at a higher density than any other system of agriculture [3, 8, 16].

In Mexico the Aztec culture collected human excreta for agricultural use. One example of this practice has been documented for the Aztec city of Tenochtitlan which was founded in 1325 and was one of the last cities of pre-Hispanic Mexico (conquered in 1521 by the Spanish): The population placed the sweepings in special boats moored at docks around the city. Mixtures of sweepings and excreta were used to fertilize the chinampas (agricultural fields) or to bolster the banks bordering the lake. Urine was collected in containers in all houses, then mixed with mud and used as a fabric dye. The Aztecs recognized the importance of recycling nutrients and compounds contained in wastewater [3,5].

In Peru, the Incas had a high regard for excreta as a fertilizer, which was stored, dried and pulverized to be utilized when planting maize.

In the Middle Ages, the use of excreta and greywater in agricultural production was the norm. European cities were rapidly urbanizing and sanitation was becoming an increasingly serious problem, whilst at the same time the cities themselves were becoming an increasingly important source of agricultural nutrients. The practice of directly using the nutrients in excreta and wastewater for agriculture therefore continued in Europe into the middle of the 19th Century. Farmers, recognizing the value of excreta, were eager to get these fertilizers to increase production and urban sanitation benefited [3, 17]. This practice was also called gong farmer in England but carried many health risks for those involved with transporting the excreta and faecal sludge.

Traditional forms of sanitation and excreta reuse have continued in various parts of the world for centuries and were still common practice at the advent of the Industrial Revolution. Even as the world became increasingly more urbanized, the nutrients in excreta collected from urban sanitation systems without mixing with water were still used in many societies as a resource to maintain soil fertility, despite rising population densities [3, 15].

Recovery of nutrients and organic matter from excreta and greywater in non-sewered sanitation systems was addressing the sanitation problems in settlements in Europe and elsewhere and was contributing to securing agricultural productivity [9]. However, the practice did not become the dominant approach to urban sanitation in the 20th century and was gradually replaced with sewer-based sanitation systems without nutrient recovery (apart from agricultural reuse of sewage sludge in some cases) - at least for cities that can afford it.

Interestingly, the use of (odorous) animal manure in agriculture continued through to this day, probably because the odor of manure was not thought to contribute to human illnesses and because the vast amount of manure could not be "flushed away" like human excreta can.

Research into how to make reuse of urine and faeces safe in agriculture was carried out by Swedish researchers, for example Hakan Jönsson and his team, whose publication on "Guidelines on the Use of Urine and Faeces in Crop Production” [4] was a milestone which was later incorporated into the WHO "Guidelines on Safe Reuse of Wastewater, Excreta and Greywater" from 2006 [10, 16]. The multiple barrier concepts to reuse, which is the key cornerstone of this publication, have led to a clear understanding on how excreta reuse can be done safely.

African societies are historically not used to utilize feces in agriculture and gardening. But EcoSan dehydration toilets with urine-diversion could be successfully implemented in the unplanned settlement of Majumbasita, a periurban area of Dar es Salaam with a total population of about 23,000. Dependence on water supply from wells recorded to be contaminated by fecal bacteria due to leakage from pit latrines, a shallow groundwater table and the collapse of existing pit latrines especially in the rainy season and the presence of diseases like diarrhea were supporting factors for the introduction of the EcoSan concept. Stakeholders were involved from the beginning of the project applying the PHAST (Participatory Hygiene and Sanitation Transformation) method and also local masons were recruited. 95 household facilities were constructed by using local material and labor. Figure 2 shows some examples of the different materials used for the superstructure of the toilets and the above ground structure of the vaults can be nicely seen as well.

Masonry Thatch Used/old iron sheets

Figure 2. Examples of EcoSan dehydration toilets with urine-diversion in Tanzania using Local Material [13]

Based on the Vietnamese double-vault dehydration toilet, an EcoSan facility was further developed and adapted to Mexican conditions. The facility looks like a standard WC but with urine-diversion and no requirement for water and can be constructed within the house without any problems of smell. The device is used and accepted by middle-class families. The toilet bowls are constructed in small family- or community-owned workshops using concrete or fiberglass and molds have been exported South Africa, Uganda and Zimbabwe where they are now mass-produced with small changes. Main motivation factors for the successful installation were water-scarcity and non-functional WCs. Two indoor bathrooms with EcoSan toilets can be seen in Figure 3

Figure 3. EcoSan Toilets in Mexican Middle-class Indoor Bathrooms [14,21]

2.2. Characteristics of Human excreta and Greywater

In Lübeck-Flintenbreite an innovative decentralized sanitation concept has been realized in a densely populated peri-urban area for a planned capacity of 350 inhabitants. Greywater and Blackwater is collected and treated separately.

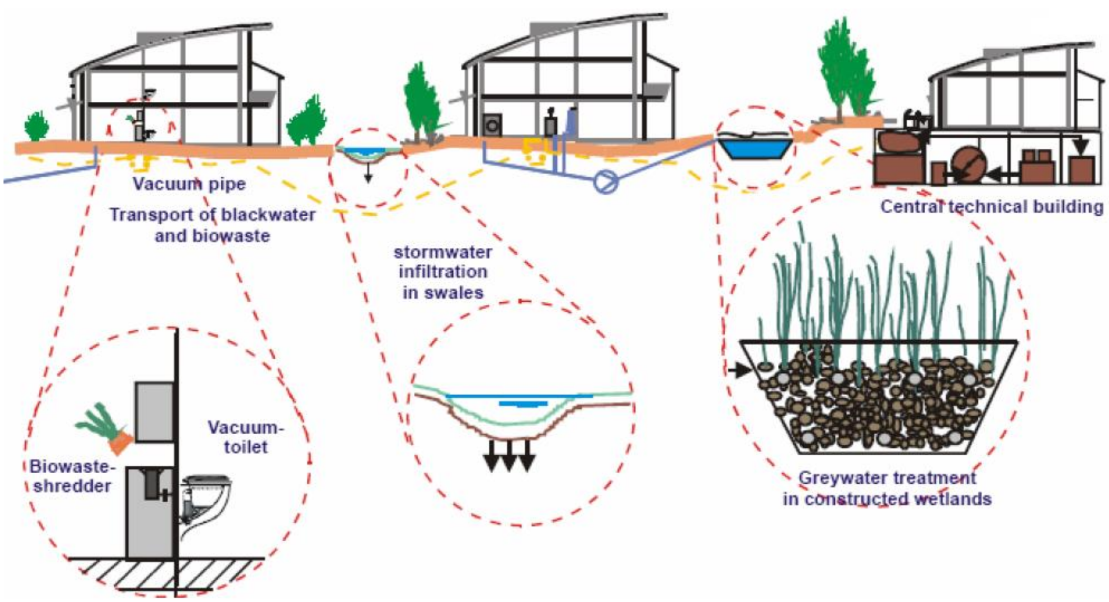

Figure 4. Schematic View of the EcoSan Concept of the Flintenbreite, Germany [15,22]

By using vacuum toilets with only 0.7 l water per flush, relatively undiluted Blackwater is collected and co-treated with shredded organic waste by anaerobic digestion after a thermal sanitization. The produced biogas is used in a heat and power generator and the digested sludge goes to agriculture with further storage for the growth period. Greywater is drained by gravity and treated via a vertical constructed wetland. Rainwater is collected by small gutters on the ground surface and infiltrated by a swale system. The economically feasible project was pre-financed by a bank and a private company operates the system with high integration of the inhabitants. Figure 4 shows the EcoSan concept of the project.

2.3. Characteristics of Human Excreta and Gray Water

In understanding the concept behind EcoSan it is helpful to take a look at the properties of the different partial flows of human wastewater like the so-called yellow water (= urine), brown water (= feces) and gray water (= from showering, washing, cleaning, *etc.*,) that are commonly mixed in conventional systems.

Figure 5 shows these properties for European conditions and indicates clearly that urine can be considered as a good resource for fertilizer due to its high content of nitrogen (N), phosphor (P) and potassium (K). Whereas fecal matter is rich in humus building organic matter and could be used as a soil conditioner. Gray water, which presents volumetrically the highest portion of wastewater, can be considered as only slightly polluted when not mixed with human excreta, which simplifies its treatment and possibility to reuse. The amount of excreta can vary in function of factors like the type of diet, the climate and lifestyle, but the proportion of nutrients and water excreted remains roughly the same independent of the total output [14, 17, 23].

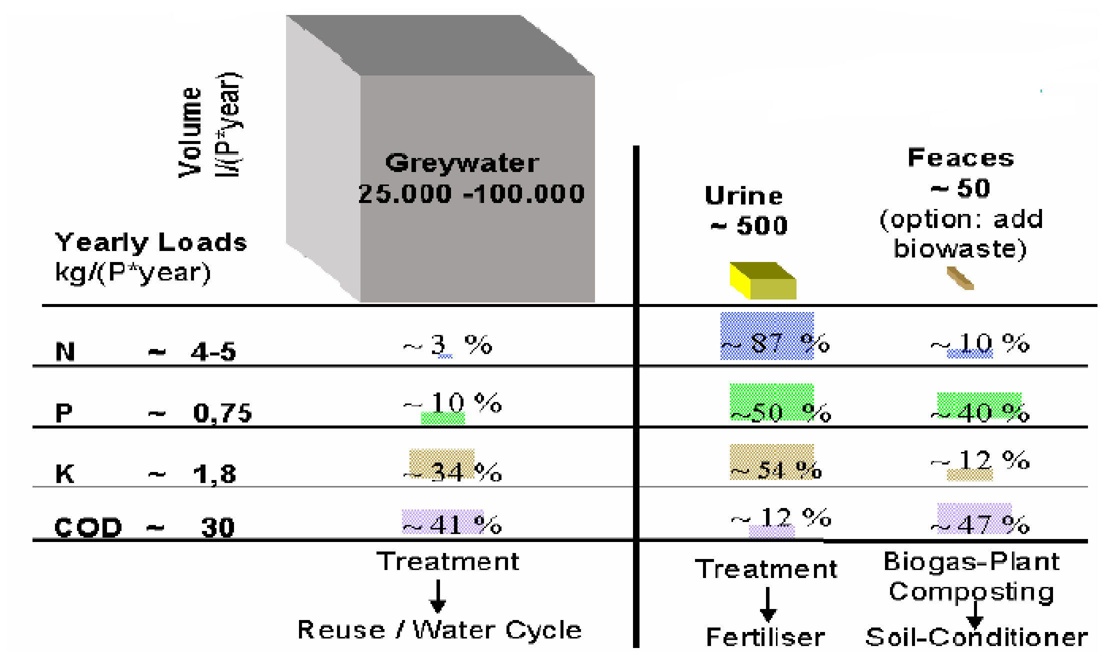

Figure 5. Characteristics of Divertible Domestic Wastewater Flows with no Dilution for Urine and Feces [16,26]

Humans excrete on average sufficient amounts of nitrogen, phosphorous and potassium as plant nutrients to grow the 230 kg of crops they need annually [11, 18]. Besides the nutrient content of the different partial flows, the distribution of pathogens is of high interest as well. Urine-transmitted pathogens are less common than pathogens transmitted by feces [12, 19, 27]. Feces are considered to be hygienically critical whereas greywater bears no major hygienic concern [17, 20, 28]. In general, appropriate treatment and handling of the products is required to prevent any possible health risks. The logical consequence of the above-mentioned would be a diversion of the different partial flows to facilitate appropriate and efficient treatment as well as reuse of the different components as it is already a common practice for industries with a modern wastewater management.

3. Methodology

The study used the inferential and descriptive methods of research with questionnaires as the main data-gathering instrument. The subjects of this study is Barangay Poro in San Fernando, La Union employed in public and private firms. The major tool for data gathering was the questionnaire. The questionnaire focused on the level of EcoSan end-users acceptance in terms of house acceptability, owner satisfaction, construction cost, and agreement on sanitation facility.

4. Results and Discussion

4.1. House Acceptability

As shown in Table 1, house acceptability obtained a mean value of 2.3 and it was interpreted as fairly acceptable which implied that the selling cost was affordable considering the current status in life of the end-users. They could afford to buy the UDDT unit. In terms of acceptability level on quality of workmanship, the mean value was 3.4 and was interpreted as acceptable. This meant that the respondents' evaluation towards UDDT unit was acceptable to them as the end users.

Table 1. Mean Responses of End-users on House Acceptability

Category	Mean	Verbal interpretation
1. Selling cost	2.3	Fairly acceptable
2. Quality of workmanship	3.4	Acceptable

4.2. Owner Satisfaction

As shown in Table 2, owners' satisfaction with the area of UDDT compared to ordinary toilet bowl it obtained 3.4 that was interpreted as satisfied. This simply showed that assessment of the end-users was having assessed that using the UDDT unit exhibited a satisfied response from the end-users. It simply showed that the application of the UDDT technology was a good alternative for conventional toilet bowl. The UDDT as sanitation facility obtained a mean value of 3.3 and was interpreted as satisfied. The respondents' evaluation on the aspect of alternative sanitation facility was also satisfactory for the reason that the end-users had been properly trained on how to use technology and they see this process as an advantage for them since they would be able to help the environment and moreover conserve water which is very important for them since they are near the sea side.

Table 2. Mean Responses of End-users on Owners' Satisfaction

Category	Mean	Verbal interpretation
1. UDDT compared to ordinary toilet bowl	3.4	Satisfaction
2. UDDT as sanitation facility	3.3	Satisfaction

4.3. Construction Cost

As shown in Table 3, the fisherman's village end-user's evaluation of the UDDT unit in terms of construction was successful. Lower cost of the UDDT unit obtained a value of 21.3 percent from the respondents and this meant that only a few believed that the cost of the construction was reduced due to the UDDT unit. Less construction materials obtained a value of 36.2 percent which signified that the people in Barangay Poro at fisherman's village believed that the construction materials had a bigger role in the cost reduction of the construction of their sanitation facility. Less labor/supervision obtained a 42.5 percent rating since the pilot area is on the provincial area. Most of the construction workers were also the local men who were helped by their neighbors. According to the fisherman's village resident, "UDDT unit really does not need any pipe connection for reason that it has its own collection area". Since all they need is to make a small storage area beneath the sanitation structure, they have been able to finish the construction within the day and this is considered as an advantage of UDDT unit.

Table 3. Frequency and Percentage Distribution of UDDT End-users on Construction Cost

Category	Mean	Percentage
1. Lower cost of UDDT unit	10	21.3
2. Less construction materials	17	36.2
3. Less labors/supervision	20	42.5
Total	47	100

4.4. Agreement

As shown in Table 4, the respondents' evaluation of the UDDT unit cost cheaper than ordinary toilet bowl had a mean value of 3 which showed that the end-users had accepted the endorsed product cost by the manufacturer. Based on the FGD to the local community that by comparing the present price of the toilet bowl that ranges from Php 1,500-3000, the price of UDDT unit was acceptable since end-user could save money and most of all can use human waste as new material. UDDT has the same quality and durability with ordinary toilet bowl. With this as one of the classification for the agreement, it obtained a value of 3.3 as its mean what implied that the UDDT unit has met the end-users expectation in terms of durability. This is interpreted as acceptable. This was analyzed thru the FGD and the local people stated that they did not see any difference except that the conventional toilet bowl has a water depository and the UDDT unit has none; this is the reason why the responses have manifested the acceptable maintenance.

Table 4. Mean Responses of UDDT End-users in Terms of Agreement

Category	Mean	Percentage
1. UDDT cost cheaper than ordinary toilet bowl	3	Acceptable
2.UDDT has the same quality and durability with ordinary toilet bowl	3.3	Acceptable

5. Conclusion

The EcoSan urine diverting dehydrating toilet (UDDT) is a timely issue since the Municipality of Sn Fernando, La Union is currently encouraging the people to recycle their waste materials.

The level of acceptability of end-users on low-cost housing unit utilizing EcoSan UDDT unit for sanitation facility among end-users in terms of selling cost is fairly acceptable. The level of acceptability of end-users on how cost housing unit in terms of quality of workmanship is acceptable to the end-users. The level of satisfaction of end-users on low cost housing in terms of comparison of ordinary toilet bowl and EcoSan UDDT unit was satisfied. The assessment of EcoSan make plausible claim that human excreta has been used to restore soil fertility for centuries.

However, this does not mean that the products of EcoSan system are economically, institutionally, or legally marketable in many countries. To improve marketability, there is a need for research on the use and marketability of excreta products. Health regulations should allow households to use their own excreta for home gardening. Moreover, the products that all put on the market should have standards to meet.

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