MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART, AND TECHNOLOGY

SCHOOL OF BUILT ENVIRONMENT

DEPARTMENT OF CONSTRUCTION ECONOMICS AND MANAGEMENT

ASSESSING THE SUITABILITY OF AN ECOSAN TOILET AS AN ALTERNATIVE TO CONVENTIONAL PIT LATRINE FOR FAECAL SLUDGE DISPOSAL IN SIRONKO TOWN COUNCIL

BY

NDYAMUBA VICTOR

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SUPERVISOR: MR. TOM MUKASA

A dissertation submitted to the Department of Construction Economics and Management for the Award of a Degree of Bachelor of Science in Construction Management of Makerere University

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DECLARATION

I, NDYAMUBA VICTOR, declare that this is an original report as a result of my efforts and the information here was compiled by myself and has not been submitted to any university or higher institution of learning for any academic award.

SIGNATURE.....

NDYAMUBA VICTOR

DATE.21../..07../..2022

This research project has been submitted for presentation with my approval as the university supervisor.

Signature.....

MR. TOM MUKASA

Date.21../..07../..2022

DEDICATION

I dedicate this report to my family, **Mr. Tumwjukye Robert**, my mum, **Mrs. Tumwijuke Anna,** the whole family, my friends and colleagues for all forms of support and encouragement they gave me success in my course and final year project.

My supervisor **Mr. Tom Mukasa**.

May God exceedingly and abundantly bless and reward them.

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I extend my sincere heartfelt gratitude to the Almighty God for granting me strength, health and courage during the period of this study.

A special appreciation goes to the family of **Mr.** and **Mrs. Tumwijuke** for the financial support, advice and encouragement they forwarded.

I acknowledge **Mr. Tom Mukasa** for his availing efforts and time rendered to me as my supervisor and parent.

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Ecosan - Ecological Sanitation.

NWSC - National Water and Sewage Cooperation.

VIP - Ventilated Improved Pit Latrine.

UDTs – Urinary Diversion Toilets.

NPV – Net Present Value.

UGX – Uganda shilling.

MoH – Ministry of Health Uganda.

WSP – Water and Sanitation Program.

ABSTRACT

Solid waste management is one of the greatest challenges facing urban authorities today in developing countries around the globe. Uganda is facing rapid urbanisation of 5.1% per annum leading to the overcrowding and the development of slums, thus exacerbating the condition of proper sanitation coverage. Despite greater sanitation coverage in Sironko District with 96% of households possessing at least a pit latrine, access to sanitation facilities does not solve the problem of improved sanitation. This is because conventional latrines normally lead to various other pressing environmental problems, along with the injustice of scarce water resources for flushing latrines to keep excreta out of sight, which means that other community-accepted sustainable solutions are needed. Therefore, considering the present context and sanitation situation of the country, there is a need for a holistic approach to call for hygienic, sustainable and eco-friendly alternatives and hence, ecological sanitation toilets.

This study argues that Uganda's historical acceptance of ecological sanitation and its recent experience in using the approach (Ecosan) in some parts of the country could be very valuable in the replacement of other approaches especially where the Ecosan toilet is the best option. It could confront these problems and provide potential "added value" to the livelihood link through agricultural production and water and environment conservation. This paper highlights the advantages of the Ecosan toilets over conventional pit latrines, cost-benefit analysis, and challenges faced by traditional pit latrine users.

1 INTRODUCTION

1.1 Background

Waste management includes the processes and actions required to manage waste from its inception to its final disposal (United-National-Statistics-Division, 2017). This includes the collection, transport, treatment, and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws, technologies, economic mechanisms.

In Uganda, waste management technologies are both onsite and offsite. Onsite technologies are those in which excreta and wastewater are collected, stored, and/or treated on the plot where they are generated. This system of sanitation is widely used in rural areas where individuals solely construct and maintain them. Some onsite sanitation technologies include conventional pit latrines, alternating twin-pit VIP, eThekwini latrines, pour-flush toilets, septic tanks, arborloos, tiger worm toilets, Ecosan toilets, among others. Offsite technologies are those in which excreta and wastewater are collected and conveyed away from the plot where they are generated. An off-site sanitation system relies on a sewer technology sewer for conveyance e.g., simplified sewer, solids-free sewer, or conventional (Elizabeth Tilley, 2014). Only found in urban areas, constructed and maintained by the government of Uganda through National Water and Sewage Cooperation (NWSC).

Sironko district where the Sironko town council is situated, is located in Eastern Uganda (Elgon sub-region). The district occupies some of the foothills of Mt. Elgon taking on the low lands and highlands for its topography. Sironko Town council specifically lies in the low land with an altitudinal range of 1100-1350mm on the windward side of the mountain which receives high levels of precipitation

The area experiences a bimodal type of rainfall with the heaviest in the first season of March- June while there is low rainfall in the second season between August–November. The average rainfall is 1550 mm per year. This heavy rainfall supports the agriculture sector, which is the base of the district livelihood. There is a short dry period from mid-June to July and a long dry period between the months of December-March.

The nature of soils is a result of resultant upon the eruption and creation of the Mt. Elgon volcanic massif. These volcanic strata consist of soda-rich agglomerates, tuffs, and lavas in a spatial and temporal discontinuous sequence. Associated with these volcanic strata are the Tertiary and

Quaternary erosion sediments that comprise conglomerates, sandstones, mudflows, and intra-erosional calcareous deposits that are widespread around the foothills of the Mt. Elgon massif. Overlying many of these sediments and occupying much of the Western and Northern portion of the district is a considerable thickness of Pleistocene to recent alluvium, black soils, and river deposits with swamp alluvium in the valley bottoms which highly account for the natural loose soils

According to the National Population and Housing Census (2014) results, Sironko District had a total population of 246,636 people with Sironko Town Council contributing 18,884 people. Most households in the area engage in subsistence agriculture where cultivation of both cash and food crops such as; coffee, bananas, beans, maize, and groundnuts in addition to raring of livestock. Other economic activities include; trading, forestry, industry, tourism, metal works and fabrication, transportation, agro-processing industry, sand mining alongside River Sironko.

Each household possess an onsite sanitation system where most of them use the conventional pit latrines because of the low capital costs, can be built with locally available materials but in the long run, there are disadvantages involved like, possible contamination of groundwater with pathogens mostly in areas of a high-water table, collapsing of the pit in areas with loose soils which can be prevented by the use of Ecosan toilet which is also an onsite sanitation system

The EcoSan toilet is an enclosed system that does not need water, so is an alternative to leach pit toilets in places where the water table is high and the risk of groundwater contamination is increased. The EcoSan toilet is based on the principle of recovery and recycling of nutrients from excreta to create a valuable resource for Agriculture. The work of the wsp (water and sanitation program) affirms that there is a role for a variety of EcoSan technologies in sanitation improvement programs, but this role will vary according to geography, economy, culture, etc. However, the priority continues to be the need to achieve health benefits through hygienic behaviour and improved sanitation facilities; environmental and nutritional benefits can follow.

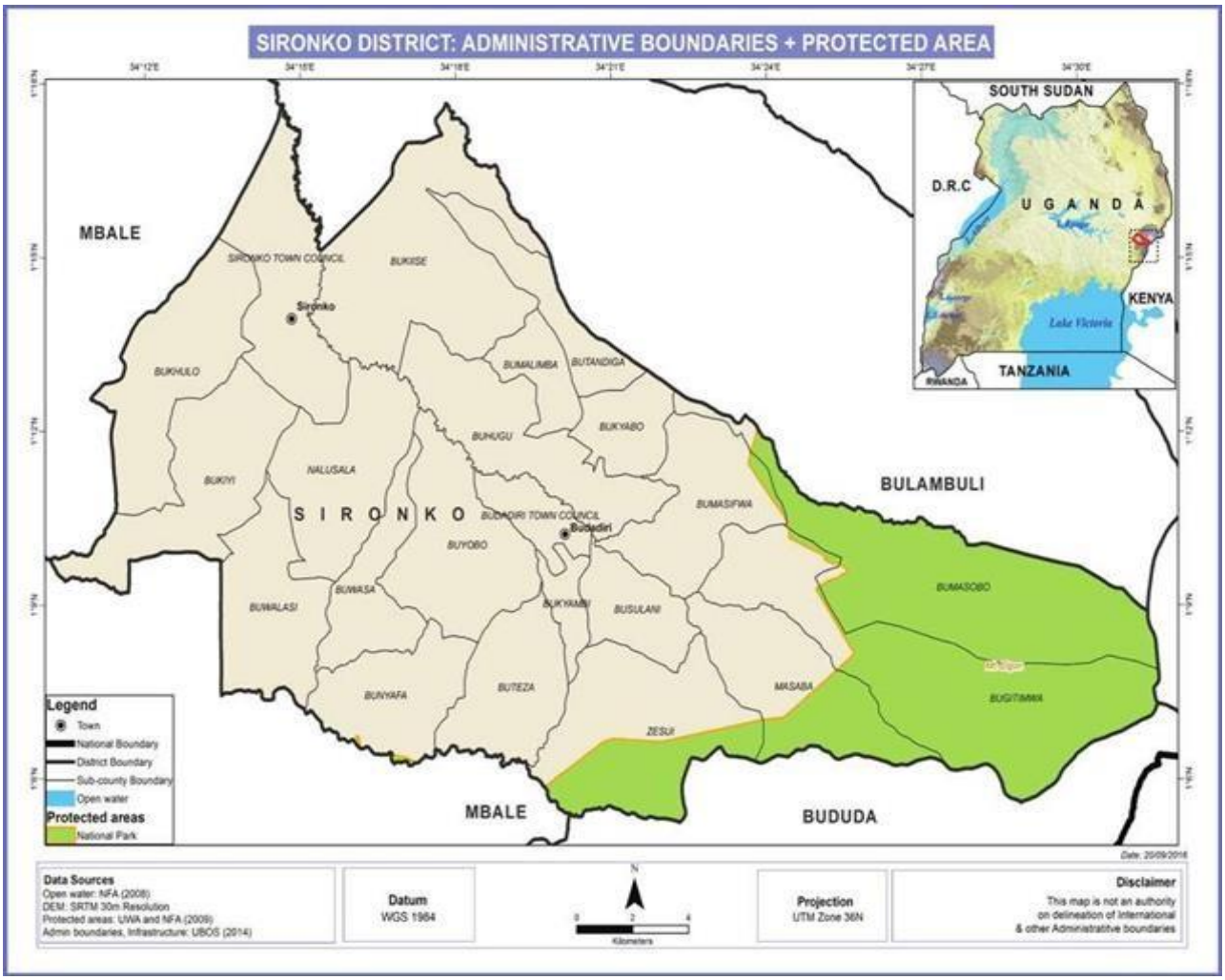

Figure 1-1: Administrative boundaries of Sironko District.

1.2 Problem statement

Sironko town council experiences a bimodal type of rainfall with an annual average rainfall of 1550mm. This heavy rainfall has ultimately led to a high-water table in the region.

The natural soils in this region are deposits of mudflows and sandstones which are widespread around the foothills of Mt. Elgon where Sironko town council is located. The process of formation resulted in the loose natural soils in the region.

The utilization of the conventional pit latrines makes them highly helpless and vulnerable to the high-water tables and loose natural soils of the area which increases the risk of collapsing and contaminating groundwater with excreta.

1.3 Objectives of the study

1.3.1 Main objective

To assess the suitability of an Ecosan toilet as an alternative to conventional pit latrines at selected points in Sironko Town Council.

1.3.2 Specific objectives

- To investigate the challenges related to the conventional pit latrines in faecal sludge disposal.
- To carry out a cost-benefit analysis for the construction and maintenance of the Ecosan toilet and the conventional pit latrines.
- To ascertain the advantages the Ecosan toilet has over the conventional pit latrines.

1.4 Justification of the study

Ecological Sanitation (ECOSAN) only began in 1997, with the South Western Water Towns Water and Sanitation Project (SWTWSP). Ecosan is cautiously promoted as one of the options to problematic environments such as collapsing soils, high water tables. Sironko Town Council is a region having a high-water table and loose soils, the use of Ecosan toilets would perform much better compared to the conventional pit latrines that are commonly being used by most households within Sironko.

This research intends to investigate whether the use of the Ecosan Toilet would be Economical, able to prevent groundwater contamination and collapse of latrines.

1.5 Significance of the study

In areas with a high-water table and loose soils, it has been evident that there is severe collapsing of latrines, Groundwater contamination. With the Ecological Sanitation approach, Ecosan toilets are more likely to achieve long-lasting toilets, cheaply constructed with minimal maintenance costs, reduce the spread of diseases and improve hygiene and general sanitation of the residents.

1.6 Scope of the study

This shall be sub-divided into three sections which include content, geographical, and time scope.

1.6.1 Content Scope

This research shall be limited to the four specific objectives; challenges related to the conventional pit latrines, advantages of the Ecosan toilet over the conventional pit latrine, cost-benefit analysis

for the construction and maintenance of the Ecosan toilet using locally available material. The study shall not include geotechnical investigation of the area and groundwater quality tests.

1.6.2 Geographical scope

The research study was carried out in Sironko Town council, Sironko District located in Eastern Uganda where key information was collected within the community.

1.6.3 Time Scope

The proposed study is estimated to take seven months from May 2021 to December 2021 from proposal inception to final project presentation provided there arise no hindrances.

Table 1.6-1: Proposed Research Work Plan

	YEAR	**2021**							
S/n	**Activity**	**MAY**	**JUN**	**JULY**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
1	Literature Review								
2	Proposal Development								
3	Proposal presentation & submission								
4	Data collection								
5	Analysis								
6	Implementation and Report writing								
7	Report Submission								

2 LITERATURE REVIEW

2.1 Introduction

This chapter presents literature related to each specific objective of the study. It also presents the theoretical review and the summary of the literature. This chapter also highlights the research gaps within the reviewed studies.

2.2 Theoretical Review

Ecological Sanitation (ECOSAN) is an environment-friendly sustainable sanitation system that regards human waste as a 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 of, ECOSAN seeks to close the loop of the nutrients cycle, conserve water and our surrounding environment (WaterAid-in-Nepal, 2011).

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: Preventing pollution rather than attempting to control it after we pollute, Sanitizing the urine and faeces, using the safe products for agricultural purposes (WaterAid-in-Nepal, 2011).

Ecosan approach was introduced in Uganda by officials of an Austrian-founded project to the Ministry of Water in 1996 as one of the options to provide sanitation facilities to rural growth centres whichdid not have easy access to safe water and adequate sanitation. The approach was favoured compared to pit latrines because latrines contaminate groundwater while flush toilets also use a lot of water at the same time contaminating water bodies especially when septic tanks are emptied into wetlands or near water sources (Austin, 2011).

2.3 Empirical Review

The full range of technical options for providing adequate basic sanitation is still not widely known nor are the characteristics of the different options well understood. In particular, there is little appreciation of the long-term financial, environmental, and institutional implications of operating and maintaining various sanitation systems. As a result, in many cases, communities and local governments are choosing technical options that, in the long term, are unaffordable and/or unsustainable (Anon, 2008).

Toilet types can be broadly split into two categories; on-site and off-site systems. Off-site systems are associated more with the developed world, cities, and high-density areas and often take on the form of sewerage systems which require a reliable water supply and the provision of wastewater treatment. Alternative on-site systems are isolated and provide some level of treatment or containment at the toilet location and avoid the need for further treatment. However, several on-site systems need regular emptying (Anon, 2008).

The simplest form of pit latrine is a hand-dug pit that is unlined and covered with a series of wooden logs strapped together allowing the user to defecate into the pit. There is possible groundwater contamination if the pit is not completely lined and the Technology is simple and not easy to construct in rocky or understandable unstable ground. They are characterized by fly and smell nuisance (Anon, 2008).

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: (WaterAid-in-Nepal, 2011).

- Preventing pollution rather than attempting to control it after we pollute
- Sanitizing the urine and faeces
- Using safe products for agricultural purposes

In 2007, Plan International introduced Community-Led Total Sanitation (CLTS) in Africa, as one of the approaches to achieving its child survival and development goals. In the last six years, 10 Plan Country Programs in the Region of Eastern and Southern Africa have already adopted CLTS as the main approach to promoting sanitation at scale. This Pan- African CLTS Programme is one of the efforts of Plan International to promote sanitation at a scale beyond the national and regional boundaries. The project was launched in January 2010 as a multi-country initiative that involves 5 countries of Eastern & Southern Africa (Kenya, Ethiopia, Uganda, Malawi, and Zambia) and 3 countries from West Africa (Sierra Leon, Ghana, and Niger). One of the aspects that is noticeable in the Programme is the weak structures of the latrines that are built by the households. Based on this analysis, the following provides some useful tips around what is the best means of construction.

Inevitably, issues ranging from terrain, soil texture to climate e.g., heavy rains (high water tables)

can all affect the durability of the latrines constructed by communities. It is notable to reflect on how several communities within the various countries in the Programme have come up with several local solutions to address this issue of collapsing latrines. Based on the overview of the eight countries in the Pan-Africa Programme, a total of four countries cited very specific solutions.

Notoriously, the lack of quality soil plays a strong role in the collapsing latrines. To avoid latrines from collapsing, due to poor soil conditions, it is important to use round pits, introduce pit linings, and reduce pit dimensions. In this brief overview paper, the focus is placed on some overall information about latrine construction and then attention is placed on some of the innovative solutions from the Plan country offices, followed by an interesting case study. Below are a few key tips around building a simple latrine:

- **Introduce pit linings**

  Pit linings should therefore if possible be made round. The material used depended on what is available and affordable. This is only possible if the pit is lined. Lining material may be difficult to find or too expensive to use. In such cases, the solution is to reduce the pit diameter.

- **Reduce pit dimensions**

  Apart from the shape, size also influences pit stability and the risk of collapse. Pits with small diameters are more stable than pits with large diameters. In areas of unstable soil, it may be tempting to compensate for the poor depth by making pits wider to achieve a reasonable volume.

- **Depth of the pit**

  Pits in unstable soils should not be made too deep as a pit collapse during the excavation may have serious consequences for the people digging. It should be possible to dig a 2 meters pit with relative safety for the builders. Should the soil collapse, it would only fill half of the pit, and the person at the bottom would only be covered up to waist level. This should allow the person to breathe while help is organized (Namwebe-Mary, 2008).

Efforts need to be put by individuals in maintenance of Ecosan toilets and only when they start to use it, the compatibility and hygienic aspects would be best understood. The structure of the toilet pan, using different openings for urine, faeces, and washing, keeping faeces dry by applying ash,

sawdust, etc., removal ofcompost once in 6 months to be used as manure, cleanliness, and aesthetic maintenance may seem to be difficult and create barriers to implementation. Most people may find it uncomfortable those excreta remains near their bedroom till it gets decomposed and not washed out of sight as in conventional flush toilets. Usage of decomposed excreta as manure in our locality for gardens and farmland is still more difficult to adapt as households would fear odour and infection through this. Consumption of food grains grown out of this manure, though it is only organic farming, is another hurdle to overcome (P-T-Nithiya, 2013).

2.4 Cost Analysis

The economic and financial performance of the Ecosan is compared with traditional pit latrine sanitation technology. The model requires input data in form of capital expenditure (CAPEX) and operational expenditure (OPEX), assigned to different elements of a sanitation system. These include costs for both hardware, such as the cost of the latrine itself and software, which includes all promotional, training, and other capacity-building activities (Schuen-Richard, 2013)

The economic analysis takes a broader perspective, which encompasses all social and environmental costs and benefits that are ascribed as the monetary value in addition to all financial expenditure and income. Economic benefits include those related to the mitigation of environmental pollution and those related to improved health and excreta reuse. As with the project financial analysis, economic costs and benefits are attributed to the household or project and are calculated in terms of the cost or benefit per household (Schuen-Richard, 2013).

2.4.1 Whole life-cycle analysis

The whole life-cycle analysis involves a long-term perspective that takes into account all costs incurred and benefits received over the total duration of a project. The planning horizon is the duration over which the whole life-cycle costs are evaluated. This is not necessarily the same as the estimated lifespan of an asset (design life). Depending on the type of asset, the quality of construction, and the chosen planning horizon, the design life may be greater than or smaller than the planning horizon (Schuen-Richard, 2013).

2.4.2 Design life and planning horizons

From a household perspective, the planning horizon equates to the duration that a family remains in one home, before moving to a different location. As well as being poorer, households living in

insecure areas (where there may be a threat of eviction) are much less likely to invest in improving household sanitation, than households in formally planned settlements.

The design life will depend on the quality of the construction. For modelling purposes, the design life for household latrines is assumed to be 10 years, but the design life for sewerage and treatment infrastructure is assumed to be 50 years (Schuen-Richard, 2013).

2.5 Summary of literature

From the literature reviewed above, Ecosan toilets perform much better in an area with high-water tables and loose collapsible soils compared to the conventional pit latrines. The literature review also indicates that sensitization of the community on how to use the Ecosan toilet will be needed which points out the knowledge gap about Ecosan toilets.

3 METHODOLOGY

3.1 Introduction

This chapter presents the methodology which was used in the study, it includes the study design, the population of the study, the sample size and selection, the sampling technique and procedure, the data collection method and instrument, validity and reliability of the study instruments, measurement of variables and data analysis techniques.

3.2 Research design

This study adopted a descriptive survey research design. This type of research allows the gathering of in-depth information that may be either qualitative or quantitative in nature. It is a theory-based design where the researcher is primarily interested in describing the topic that is the subject of the research.

This method included data collection, analysis, and presentation. It lets the researcher clearly present the problem statement to allow others to better understand the need for this kind of research. The data gathered from the study area was categorized and interpreted. This data was both primary and secondary. Primary data was gathered by; Conducting Site visits and use of questionnaires in the study area, field survey and the Secondary data source was from; the review of documents written like journals, books, and other research papers. Then analysis and discussion of the data were made, conclusions drawn and recommendations of the results were made.

3.3 Population of the study

A Study population refers to the entire group of people, events, or things of interest that the researcher wishes to investigate (Sekaran, 2016). For this study, emphasis was put on Sironko Town Council in Sironko District.

3.4 Sampling Design.

The research used a probability sampling design. Probability sampling involves random selection, allowing you to make strong statistical inferences about the whole group. This was used to collect quantitative data. Simple Random sampling designs were used to give every member of the population an equal chance of being selected. The sampling frame included the whole population

3.4.1 Sampling Procedure.

For simple random sampling, I noted all the names of respondents on pieces of paper, folded them and then poured them in a container, mixed them thoroughly, and then requested members to pick. Respondents, whose names were chosen, were the ones that participated in data collection. While purposive samples were derived by identifying members with vital information and scheduled appointments for the interview. I selected the purposive participants based on their knowledge about the study.

3.4.2 Sample Size.

The sample size was calculated using the formula Yamane‘s (1967), for calculating sample size. The research used this formula because it is appropriate for the study as it offers an accurate sample size and is easy to apply.

3.5 Data Collection

The study considered both primary and secondary data sources.

Primary data; Primary data was obtained from residents of Sironko Town Council in Sironko district using questionnaires that were given to the respondents, and interviews with selected families. The selections were purposively and simple randomly. This is because the nature of the research requires data collection using both questionnaires and interviews.

Secondary data; Secondary data was gathered from the already existing documents and reports, journals, and published reports among others.

3.5.1 Data Collection Methods

I employed both questionnaire and interview methods for data collection. The study triangulated data sources, methods, and tools to improve data validity.

Questionnaire Method; A self-administered both close-ended and open-ended questionnaire on the Conventional pit latrines and Ecosan toilets. The questions were in line with the construction, maintenance, and use, it was in a logical order in which the subjects responded in writing. The questionnaire had a 5-point Likert scale ranging from:

5= strongly agree, 4 = Agree 3= Not sure, 2= Disagree and 1= strongly disagree

Interview Method; The study used key informant interviews where the researcher met face to face with the selected interviewees and asked them questions related to the study objectives. I scheduled appointments for interviews from which responses were recorded in a notebook. Semi-structured interview guides were used to stimulate respondents into detailed discussions. The interview guide helped to standardize the interview.

3.5.2 Data Collection Procedure

An Introductory letter was obtained from the department of construction, economics, and management to permit the researchers to collect data. Anonymity and confidentiality of the respondents will be observed by not asking the respondents for their names and contacts on the questionnaires. The introductory letter from the department of construction, economics, and management was used during data collection.

3.6 Data Quality Control

Data quality control helped ensure that the data collected has minimal errors which include validity and reliability. Validity is the extent to which the research instruments measure what they are intended to measure (Oso-&-Onen, 2008). Reliability is the extent to which a research instrument yields consistent results across the various items when it is administered again at a different point in time (Sekaran, 2003).

3.6.1 Validity

Validity simply means the ability of a research instrument to measure as accurately as possible what it is intended to measure so that meaningful inferences are made from the research results (Mugenda.O-&-Mugenda.A, 2003). The validity of the instrument was tested using the content validity index (CVI) using expert judgment, variables scoring above 0.7 will be accepted (Amin, 2005). I used one research expert to check whether the questionnaire measured what it was supposed to measure.

The Content Validity Index was measured using the formula Equation 1: CVI formula

$$CV1 = \frac{Number\ of\ items\ declared\ valid}{Total\ number\ of\ items}\ X\ 100$$

3.6.2 Reliability

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. The reliability of an instrument can be tested using the Cronbach alpha tests for reliability where the instruments are deemed reliable if they are more than 0.70. According to Sekaran (2016), Alpha values for each variable under study should not be less than 0.6 for the statements in the instruments to be deemed reliable.

3.7 Data analysis and Presentation

Data were processed, analyzed, and presented as shown below;

3.7.1 Data processing

Data collected from the primary source was compiled, sorted, edited for accuracy and clarity, classified, coded into a spreadsheet, and analyzed using a computerized data analysis package/tool known as Microsoft Excel. The calculation of these two values is similar, but the input data and costing factors are different in each case that is for the Ecosan toilet and traditional pit latrine.

3.7.2 Data presentation

Frequency distribution tables, cross-tabulation, charts, and graphs were used to interpret the data collected from the field.

4 FINDINGS AND DATA ANALYSIS

4.1 Introduction

This chapter presents the findings according to the data collected. The findings are analyzed, interpreted and presented according to the important variables, objectives of the study.

4.2 Response rate

The response rate was good; 120 questionnaires were filled, 15 were not filled. Respondents responded positively.

4.3 Personal Data

To appreciate the reliability and the accuracy of the research findings, I identified the respondents‟ biodata in respect of gender, age, and religion.

Table 4.3-1: showing gender of the respondents

Gender	Frequency	Per cent	CumulativePercent
Male	46	38.3	38.3
Female	74	61.7	100.0
Total	120	100.0	

Source: primary data

According to the findings, 38.3% of the respondents were male and 61.7% were female. This implies that there was gender bias in the study.

Table 4.3-2: showing the age of the respondents

Age range	Frequency	Per cent	CumulativePercent
<20	22	18.3	18.3
20-30	26	21.7	40.0
31-40	37	30.8	70.8
41-50	19	15.8	86.6
51-60	09	7.5	94.1
61 & above	07	5.9	100.0
Total	120	100.0	

Source: Primary Data

The study findings indicated that 18.3% of the respondents were less than 20 years, 21.7% were

20-30 years, 30.8% were 31-40, 15.8% were 41-50, 7.5% were 51-60 and 5.9% were 60 and above years old. This indicates that the majority of respondents were mature enough to answer questions in the questionnaires.

Table 4.3-3: showing education level of respondents

Education level	Frequency	Per cent	CumulativePercent
University	15	12.5	17.5
Vocational	26	21.7	39.2
Secondary	42	35.0	70.9
Primary	24	20.0	89.2
None	13	10.8	100.0
Total	120	100.0	

Source: primary data.

It was established that 12.5% had attained university education, 21.7% had graduated from vocational institutions, 35% had accomplished secondary school, 20% had finished primary education and 10.8% didn't attend school. The majority of the respondents had attained secondary education.

Table 4.3-4: showing the religion of the respondents

Religion	Frequency	Per cent	Cumulative Percent
Muslim	28	23.3	23.3
Non-Muslim	92	76.7	100.0
Total	120	100.0	

Source: primary data.

The table shows the respondents' religion. Religions were grouped in two categories since only Muslims had a differentiated way of using the toilet. Muslims made up 23.3% of the sample size and the rest were Christians.

4.4 Findings on the challenges related to the conventional pit latrines in faecal sludge disposal.

Findings on the challenges related to the conventional pit latrines in faecal sludge disposal were

evaluated in terms of the level of comfortability, the height of the water table, life span, nature of the soils, and health.

4.4.1 Challenges associated with the level of comfortability.

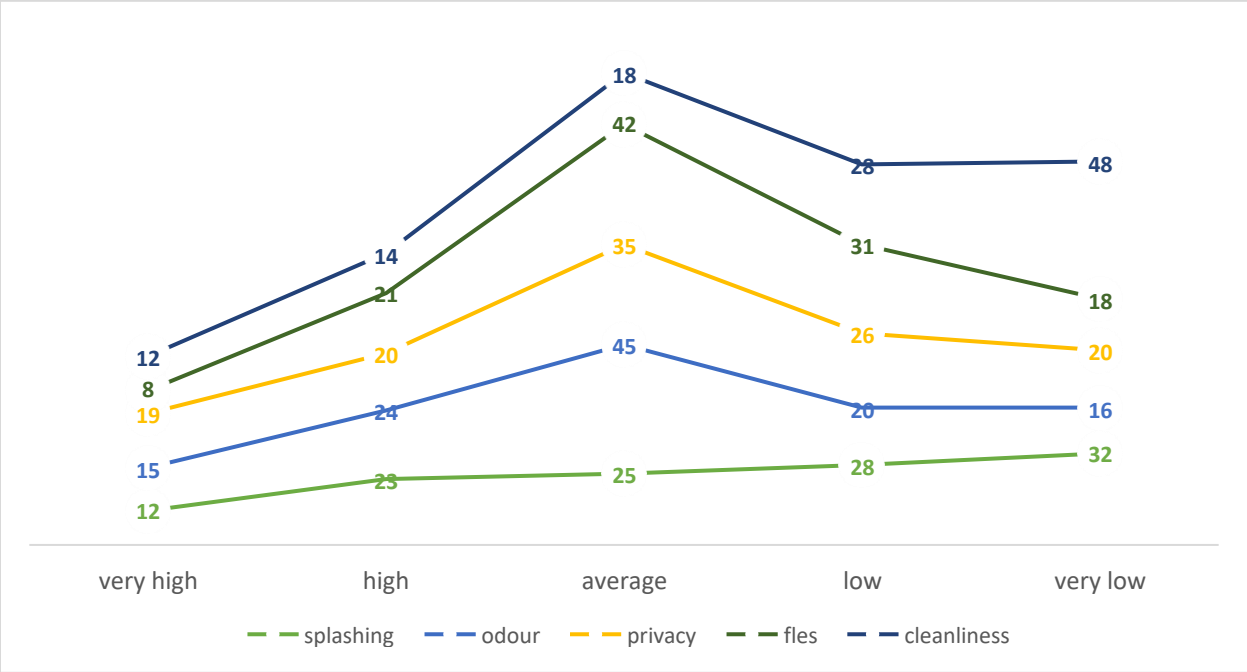

Figure 4-1: A line graph showing challenges associated with the comfortability of users and how they rated these challenges.

The findings in the figure above show that the level of comfortability in the aspect of splashing waters while in usage is low as 26.7% of the respondents considered it very low, 23.3% considered it low and only 10% considered it very high implying that majority of the sample size is not comfortable.

The level of comfortability in line with bad odours is average as the biggest portion of 37.5% of the respondents considered it average. Then those considering it, very high, high, low, and very low contribute the other percentage.

In the aspect of privacy, the majority of the sample size considered the level of comfortability average with a score of 29.2% and the other four rankings contributed 70.8%.

Flies in the superstructure of these latrines affected the comfortability averagely as the majority of the respondents considered it average with a score of 35%.

The level of comfortability considering the aspect of cleanliness of the latrine was considered very

low as 40% of the respondents considered it very low and the other ranking divisions contributed the other percentage as shown in the figure above.

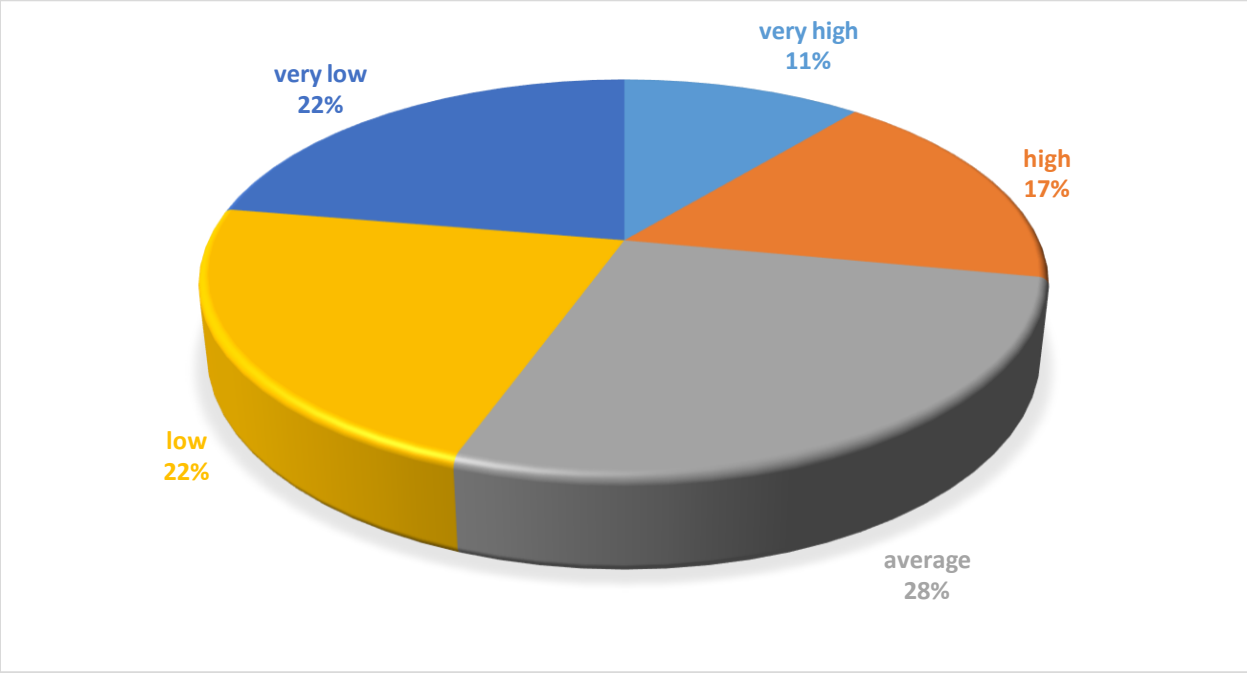

Figure 4-2: A pie chart showing the level of comfortability with all factors accounted for.

The findings above show that the level of comfortability considering all factors is average as the majority 28% considered it average, 22% considered it low and very low, 17% considered it high, and only 11% considered it very high.

4.4.2 Challenges associated with the height of the water table.

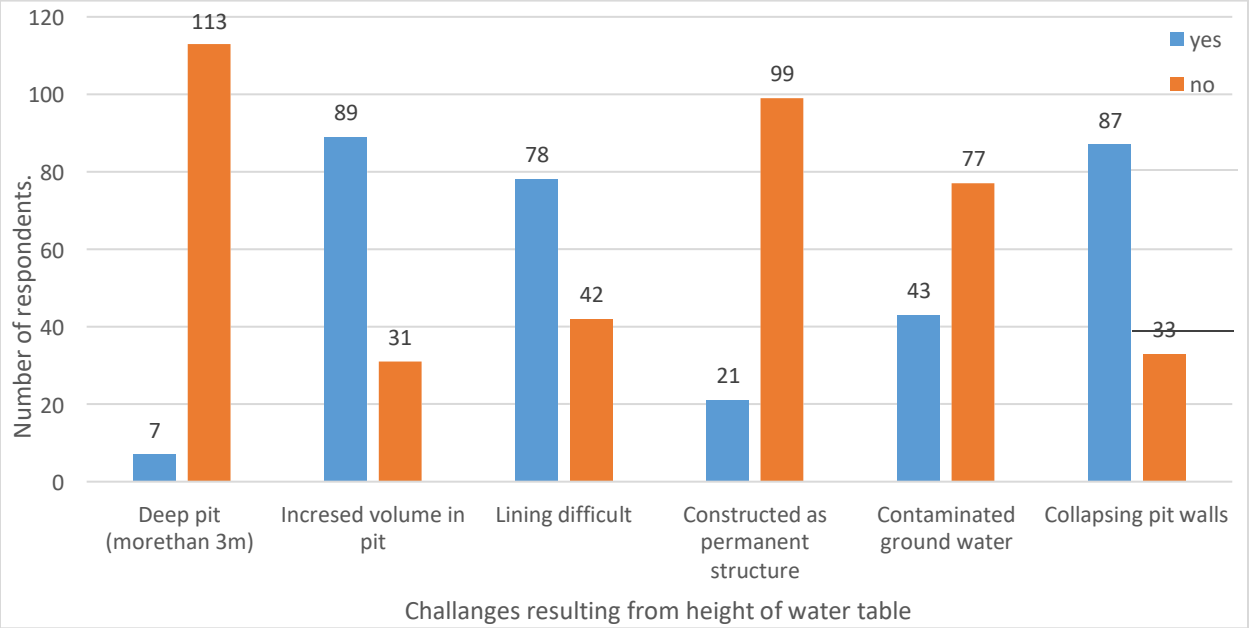

Figure 4-3: Challenges resulting from height of water table

Results in the figure above show that 94.2% of the respondents have shallow pits of less than 3m and the minority have those above 3m deep.

74.2% of the respondents agreed that their pits' volume increased because of the high-water table and 25.8% of the respondents disagreed.

65% of the respondents agreed that lining their pits is difficult because of the high-water table and 35% of the sample size disagreed.

82.5% of the respondents disagreed that their pit latrines are constructed as permanent structures and 17.5% of the sample size agreed. This is highly affected by the water table.

64.2% of the respondents disagreed that groundwater is contaminated because of the high water table and 35.8% of the sample size agreed. This score is because many people were ignorant of whether the high-water table contributes to groundwater contamination.

72.5% of the respondents agreed that pit walls collapsed because of the high-water table and 27.5% of the sample size disagreed.

4.4.3 Challenges associated with the life span of the toilets.

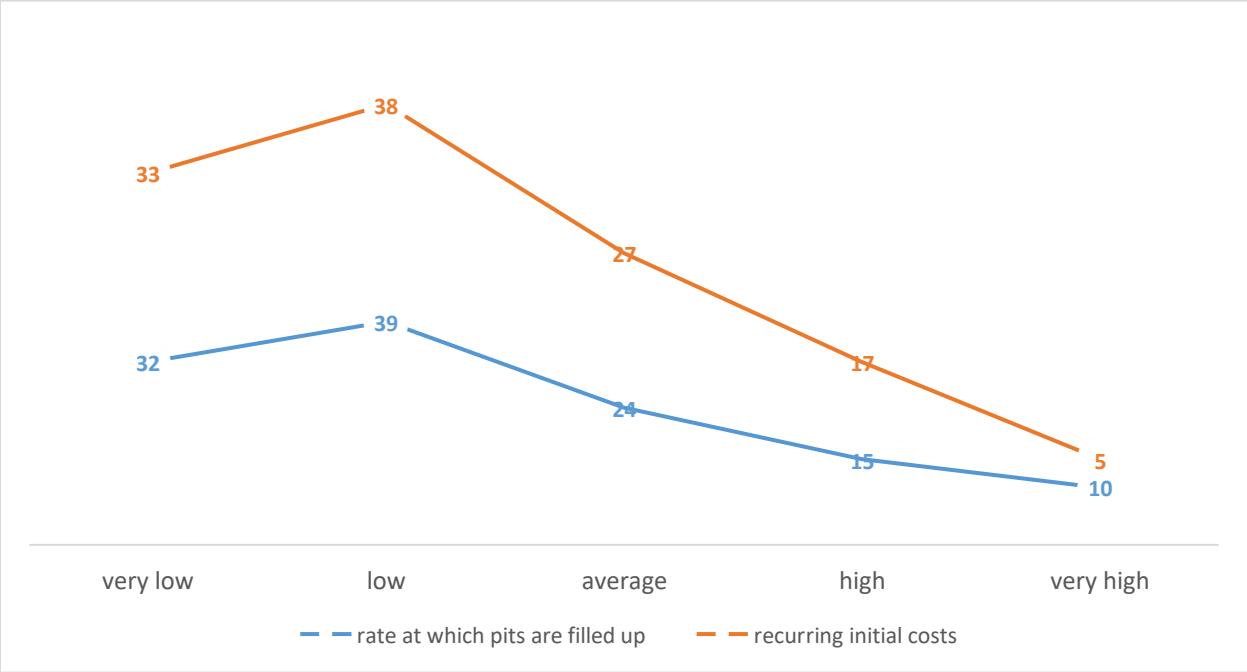

Figure 4-4: Challenges associated with the life span of latrines.

The findings in Figure 4-6 show that the rate at which the pits are filled up is high as 32.5% of the respondents considered it high, 26.7% considered it very high, 20% considered it average, 12.5% considered it low, and only 8.3% considered it very low implying that the life span of these latrines is so low with an average of 3 years.

In the aspect of recurring initial costs, the majority of the sample size considered it high with a percentage of 31.7% implying the life span is low and it requires the construction of new latrines.

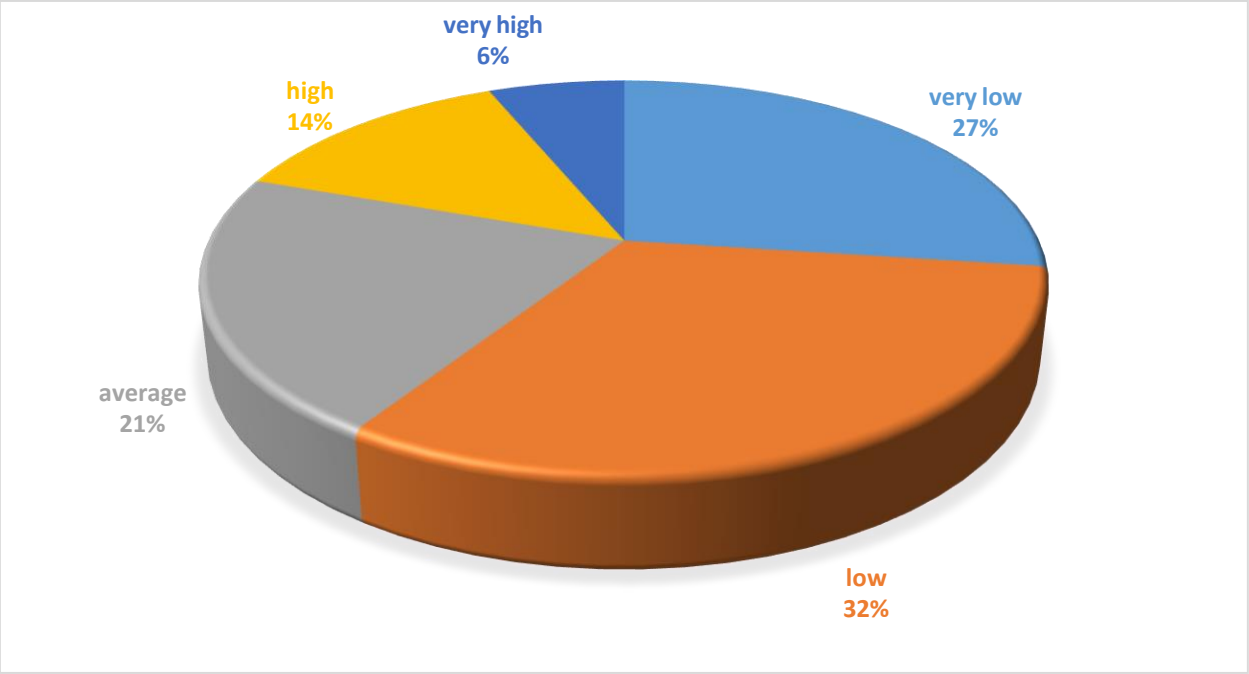

Figure 4-5: A pie chart showing the life span of the pit latrines with all factors accounted for.

The findings in Figure 4-7 show that the life span of the conventional pit latrines considering the two factors is low as the majority 32% considered it low, 27% considered it very low, 21% considered it average, 14% considered it high, and only 6% considered it very high.

4.4.4 Challenges associated with the nature of soils.

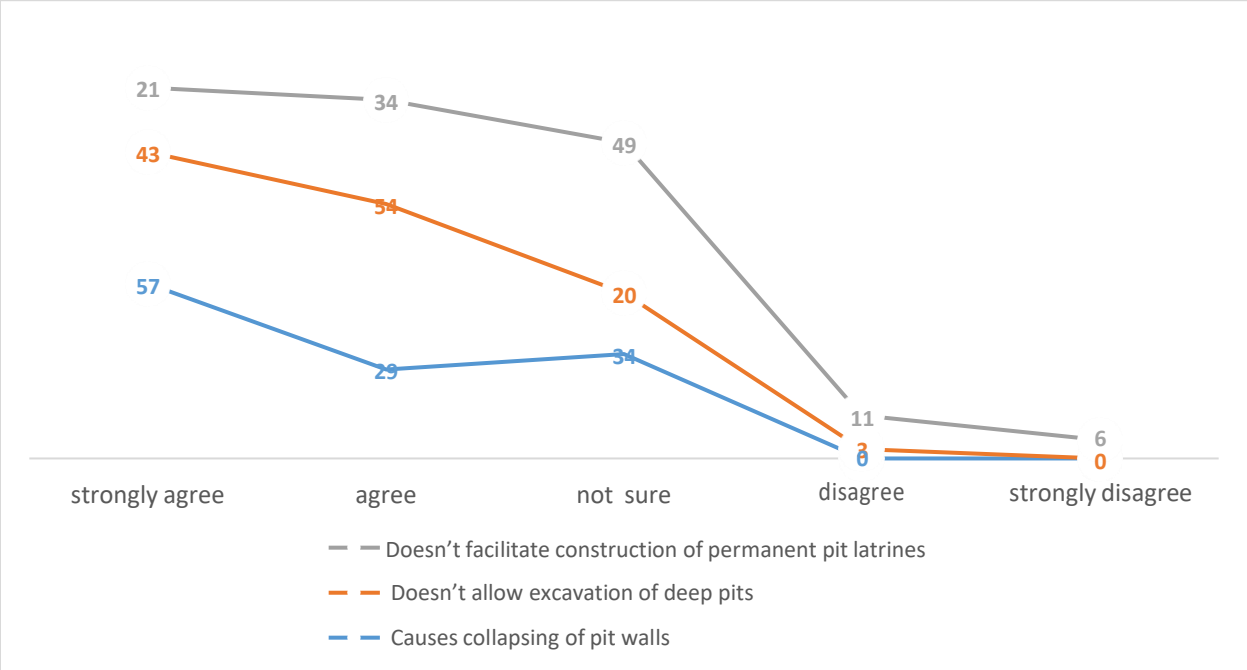

Figure 4-6: Challenges associated with the nature of the soils.

The findings in Figure 4-7 show that the nature of soils highly contributes to the challenges faced in pit latrines. In the aspect of the construction of permanent structures, the majority of respondents, 40.8% were ignorant of whether it hindered the construction of permanent structures.

In the aspect of excavation of deep pits, the majority of the respondents agreed with the statement making a score of 45% of the whole number of respondents.

According to the majority of respondents, the nature of soils contributes much to the collapse of pit walls as 47.5% of the respondents strongly agreed that the nature of soils contributed to the collapse of pit walls.

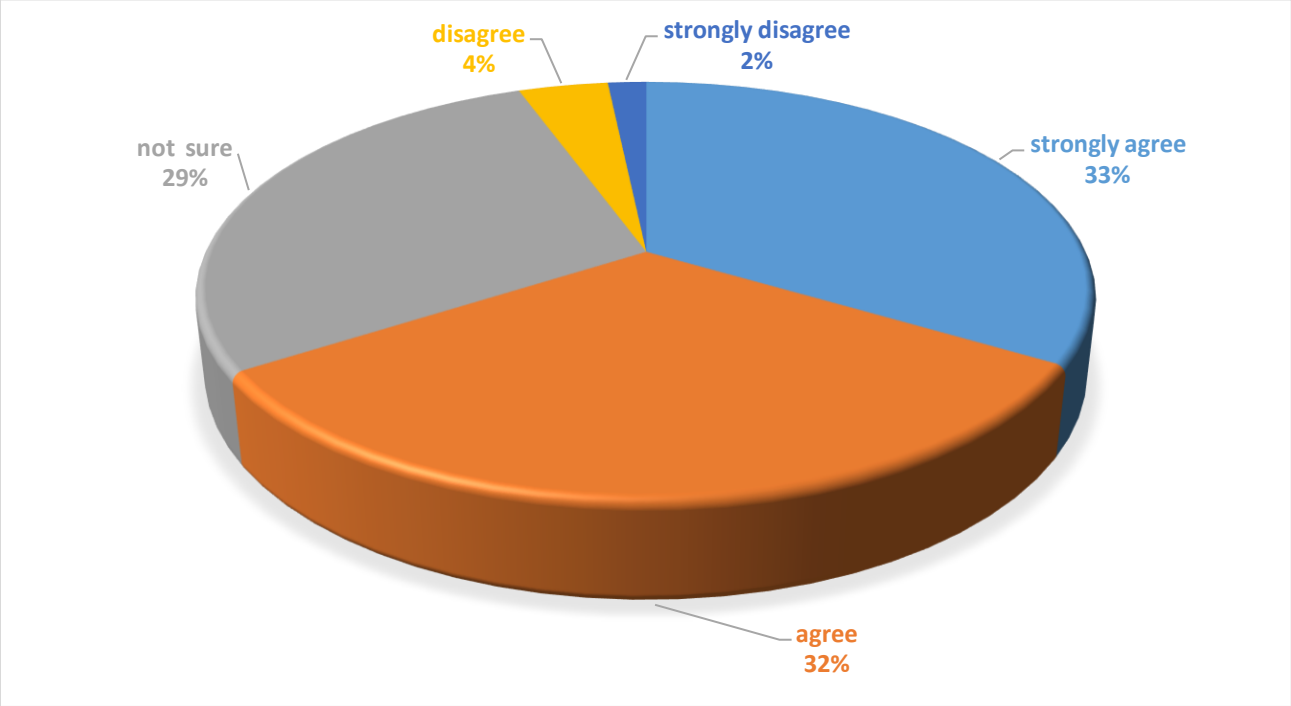

Figure 4-7: A pie chart showing the respondents' reaction to the roles of nature of soils in the challenges faced by pit latrines.

The results in Figure 4-9 show that the majority of the respondents, 33% strongly agreed that the nature of soils contributes to the challenges faced by pit latrines owners considering all the aspects in Figure 4-8. 32% of the sample size just agreed, 29% were not sure whether the nature of soils contribute to the challenges faced by pit latrine owners, 4% disagreed with this statement, and only 2% strongly disagreed.

4.4.5 Challenges associated with the health

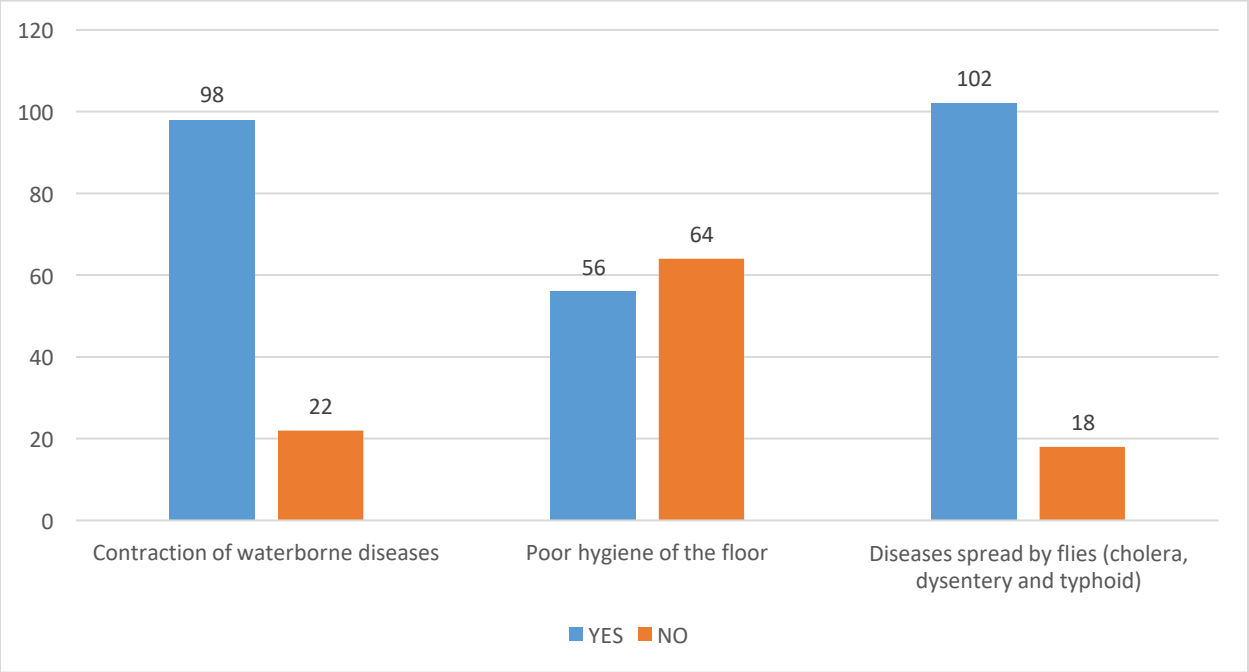

Figure 4-8: Challenges associated with the health of respondents.

Results in the figure above show that 81.7% of the respondents agreed that there is a challenge of the spread of waterborne diseases resulting from the use of traditional pit latrines and only 18.3 % disagreed with the statement.

53.3% of the respondents disagreed that the hygiene of the floors in pit latrines was not a challenge since they maintained their pits clean through smoking the pits and other hygienic practices. 46.7% of the respondents agreed with the statement.

85% of the respondents agreed spread of diseases by flies is a challenge to pit latrine owners and this was opposed by 15% of the respondents.

4.5 Findings on the cost-benefit analysis for the construction and maintenance of the Ecosan toilet and the conventional pit latrines.

4.5.1 Costing and Financial analysis for each sanitation system.

Costs and financing play an important role in planning sanitation schemes and selecting appropriate technologies. This section summarizes some of the studies related to the financial aspects of the EcoSan toilet and the conventional pit latrine in Sironko town council. Normally, the financial aspects of projects are assessed using financial or economic analysis. Financial analyses

assess the costs borne by the end-users and the direct revenue from the project.

The following key assumptions are made for financial analysis:

- The construction time for EcoSan toilets or the conventional pit latrine is less than one year.
- All costs and benefits are expressed in December 2021 prices.
- The generation of benefits is the values of faeces collected in the toilet as urine is just disposed of.
- Financial analysis of the toilet is carried out over 5 years.
- The residual value of the civil structure of the ecosan toilet is assumed to be 75% of the initial cost and 15% for the conventional pit latrine in the fifth year.

4.5.1.1 Ecosan toilet (Single Door Double Vault with Brick Superstructure)

Table 4.5-1: Showing Elemental cost plan of an ecosan toilet.

Ref	Description	Quantity	Unit	Rate (UGX)	Total (UGX)
1.1	**Substructure**				
1.1.1	Excavation works	2.4	m2	8000	19200
1.1.2	Hardcore blinding: 150mm thick	0.9	m2	50000	45000
1.1.3	Sand blinding: 50 mm thick	0.3	m2	50000	15000
1.1.4	concrete blinding 1: 2: 4 mix 300mm thick	1.8	m3	280,000	504000
	Substructure Sub-total				**583200**
2.1	**Superstructure**				
2.1.1	Walling: 100 x 100 x 200mm bricks with 1:3 mortar	21.4	m2	38000	813200
2.1.2	Top floor slab: 100mm thick	3.06	m2	35000	107100
2.1.3	Door	1	item	30000	30000
	Superstructure Subtotal				**950300**
3.1	**Fittings and equipment**				
3.1.1	PVC pipes: 50mm Diameter, bend, tee, glue, plug	10	m	15000	150000
3.1.2	Vault covers	2	item	18000	36000
3.1.3	Urine containers: 100 litres	2	item	12000	24000
	Fittings and equipment Subtotal				**210000**
4.1	**Roof**				
4.1.1	Shed roof: corrugated iron sheet covering	3	item	32000	96000
4.1.2	Truss: timber 100mm x 50mm, 3.0m	8	m	20000	160000
4.1.3	**Roof Subtotal**				**256000**
	Total				**1999500**

The total construction cost, based on market prices in December 2021, is estimated at UGX.1,999,500

Financial analysis

1. Basic calculations

- The total construction cost =UGX 1999500
- Take 5% extra (contingency) =100000
- The Final construction cost UGX. 2,099,500 (approx.)
- The total cost of maintenances / cost to run the toilet = UGX. 90000 per annum

Income from faeces production. (Assuming a family of six members)

- Annual production of excreta = 350kg
- The value of excreta as a decomposed soil fertilizer (estimated) = UGX. 500/kg
- The annual total estimated value of the soil fertilizer = UGX. 175000.

2. Benefit /Cost Ratio

Benefit/Cost Analysis Decision Aid is based on a common financial decision model for evaluating projects or proposals. B/C ratio must be greater than one for the project to be accepted.

- PV stands for present value.
- Depreciation value = UGX. 30000/ year
- Total depreciation in 5 years = UGX. 150000
- Net worth of infrastructure at 5 years = 1,949,500
- Salvage value at 5 years = 75% of 1,949,500= UGX. 1,462,125
- I = 10%

Year	0	1	2	3	4	5
Benefits	0	175000	175000	175000	175000	1462125
Disc Factor I =10%	1.00	1.10	1.21	1.33	1.46	1.61
PV Benefits	0	159091	144628	131480	119527	907865
Cost	2099500	90000	90000	90000	90000	0
PV Cost	2099500	81818	74380	67618	61471	0

Sum benefits = 1462591
Sum costs = 2384788
B/C = 0.613

4.5.1.2 Conventional pit latrine (Single Door with Brick Superstructure)

Table 4.5-2: Showing Elementary cost plan of a conventional pit latrine.

Ref	Description	Quantity	Unit	Rate (UGX)	Total (UGX)
1.1	**Substructure**				
1.1.1	Excavation works	9	m3	25000	225000
1.1.2	Pit slab: 100mm thick	1.25	m3	12000	15000
	Substructure Sub-total				**240000**
2.1	**Superstructure**				
2.1.1	Walling: 100 x 100 x 200mm bricks with 1:3 mortar	12.5	m2	38000	475000
2.1.2	Door	1	item	30000	30000
	Superstructure Subtotal				**505000**
3.1	**Fittings and equipment**				
3.1.1	PVC pipes: 50mm Diameter, glue, plug	2.9	m	15000	43500
	Fittings and equipment Subtotal				**43500**
4.1	**Roof**				
4.1.1	Shed roof: corrugated iron sheet covering	3	item	32000	96000
4.1.2	Truss: timber 100mm x 50mm, 3.0m	6	m	20000	120000
	Roof Subtotal				**216000**
	Total				**1004500**

The total construction cost, based on market prices in December 2021, is estimated at UGX. 1,004,500

Financial analysis

1) **Basic calculations**

- The total construction cost =UGX 1,004,500
- Take 5% extra (contingency) =50,000
- The Final construction cost UGX. 1,054,500 (approx.)
- The total cost of maintenances / cost to run the toilet = UGX. 70,000 per annum

2) **Benefit /Cost Ratio**

Benefit/Cost Analysis Decision Aid is based on a common financial decision model for evaluating

projects or proposals. B/C ratio must be greater than one for the project to be accepted.

- PV stands for present value.
- Depreciation value = UGX. 120000/ year
- Total depreciation in 5 years = UGX. 600000
- Net worth of infrastructure at 5 years = 454,500

Salvage value at 5 years = 15% of 454,500 = UGX. 68,175

- I = 10%

Year	0	1	2	3	4	5
Benefits	0	0	0	0	0	68175
Disc Factor I =10%	1.00	1.10	1.21	1.33	1.46	1.61
PV Benefits	0	0	0	0	0	42331
Cost	1054500	70000	70000	70000	70000	0
PV Cost	1054500	63636	57851	52592	47811	0

Sum benefits = 42331
Sum costs = 1276391
B/C = 0.03

4.6 Findings on the advantages the Ecosan toilet has over the conventional pit latrines.

Statistically, only 34% of the respondents knew about the ecosan toilet and only 7% of the sample size knew how to use this sanitation technology. This made it evident that the majority of people of Sironko were ignorant about the ecosan toilet and its usage. It made less sense to collect data about the advantages of the ecosan toilet from this sample size. The researcher adopted the use of secondary data from reports already published for areas where this sanitation technology is already being used.

If the vision of ecological sanitation could be realized, then it would confer many advantages to the environment and households & families.

4.6.1 To the environment.

If ecological sanitation could be adopted on a large scale in Sironko town council, it would protect the groundwater accessed from the multiple boreholes and R. Sironko from faecal contamination.

This is guaranteed once the ecosan toilet is designed properly. Its vaults are lined and don't need deep excavations (not exceeding 500mm) making it impossible for groundwater contamination.

Ecosan toilets also allow the recovery of the resource value of faeces. Human faeces can be turned into valuable soil conditioners. But faeces may also contain dangerous micro-organisms. Before we can recycle faeces back to the soil, these pathogens must be destroyed. Pathogen destruction, as well as handling, is safer, easier and less costly if the faeces are not mixed with urine and water which is very possible with the urine diversion toilet.

Large scale recycling would rejuvenate Sironko's agriculture. Returning human urine and sanitized faeces to farms regularly has the potential to restore soil nutrients to levels at which productivity will rise. Farmers would require less amount of expensive commercial fertilizers, much of which today washes out of the soil into water, thereby contributing to environmental degradation.

4.6.2 To households and families

Ecosan systems, if properly managed and maintained do not smell or produce flies and other insects. This is a great advantage over ordinary pit toilets. Urine and faeces do not come into contact to produce the smell. Moisture levels are too low for fly breeding.

A frequently heard objection to ordinary pit toilets is that small children may fall into them and die. Ecosan systems pose no such risk because they are neither deep nor wet and are usually built entirely above ground.

No matter how unpleasant the immediate environment may be, individual households can improve their conditions considerably by adopting an ecosan toilet. There is no need to wait for the authorities to come and install piped water and a sewerage system. The device itself can be relatively inexpensive and is not difficult to build. Households can immediately have the privacy, convenience and aesthetic advantages of an odourless and flyless toilet, attached to or even built right into their homes, however small.

The health benefits of toilets are usually not an important selling point for consumer acceptance. However, some consumers may find it attractive to know that if a large area of their community can be made more sanitary, the likelihood of diarrhoea, worm infections, and waterborne diseases will decrease, leading to overall better health of members of society.

The nutrition of families would also improve if urine and faeces were recycled to grow additional vegetables in garden plots. The fertilizer value of recycled urine and the soil-improving properties of decomposed faeces should produce excellent crops even from poor soil. This again is particularly important for women as they normally are the ones responsible for the household's food production in Sironko town council.

The emptying of ordinary pit toilets is messy, expensive and technically difficult. In many informal settlements. If contents are removed by hand, the sludge is smelly, wet and dangerous to the workers. Ecosan systems based on dehydration or decomposition reduce the volume of material to be handled and transported and result in a dry, soil-like, completely inoffensive and easy-to-handle product. As the toilet is built completely above ground there is easy access to the sanitized faeces for recycling and easier management of contents for pathogen destruction.

A great problem of building toilets in some areas is the subsoil and groundwater conditions. In some areas, the ground is too hard for digging. In other areas, the water table is close to the surface. Both conditions prevent or make difficult the construction of pit toilets, VIP toilets or pour-flush toilets.

As ecosan systems can be built entirely above ground, they allow construction anywhere a house can be built, they do not collapse, they do not destabilize the foundations of nearby buildings, unlike the traditional pit latrines.

It is often said that one cannot have good toilets without water. This is because some sanitation systems depend on water for the transport of faeces and urine to an off-site location. Most ecosan toilets need no water, for many designs, water is harmful to their proper functioning.

Over half the population of the developing world has no sanitary system of excreta disposal. The market for appropriate sanitation devices is enormous and the demand is there. The majority of ecosan toilets do not require expensive or high-tech equipment. Jobs can be created for builders and collectors of urine and sanitized faeces. These products can be sold to farmers or households could use them to improve the fertility of their farmyards.

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the questionnaire survey, observation, interview with key persons, conversation with conventional pit latrine users. Some of the conclusions drawn are mentioned here.

5.1 Conclusions.

Based on the study and discussion with some experts, the following conclusions were drawn.

5.1.1 Cost of the ecosan toilets

The cost of ecosan (dry toilet) is also in the question of people. The people compare the cost of ecosan toilets with that of the conventional pit latrine. The construction cost of an ecosan toilet is indeed way higher than that of a traditional pit latrine.

Considering the life span of the ecosan toilet which is estimated at 50 years, the benefit-cost ratio of 0.6 determined in chapter 4.5.1, the investment is recovered by the users in approximately 9 years which is impossible in conventional pit latrines whose life span is at 5 years. These triggers recurring initial costs as new pits are excavated and new latrines are constructed. In the long run, Ecosan users will save and get some income. The costs of these conventional pit latrines are more or less the same as that of ecosan toilets.

5.1.2 Environmental factors

The environmental benefits of the ecosan toilets are not considered much by the users. The main reason for this is due to the lack of proper rules and regulations for the prevention of pollution in natural water bodies and ignorance by the pit latrine users that they pave way for groundwater contamination in areas with a high-water table like Sironko town council. In this situation, it is very obvious that the value of environmental protection will be insignificant.

5.1.3 Social status of the ecosan toilets

There is a misconception about the type of toilets. In the mindset of people, more water-consuming and costly toilets are the best. This kind of concept forced the people to install water carriage toilets for those with capacity and those without to keep with the conventional pit latrines

At present, most of the ecosan toilets are constructed in poorer communities with financial subsidies, which also created a misconception among people that the ecosan toilets are for poor people and it is the inferior ones.

5.1.4 Acceptance ladder

Only 23.3% of the Sample size that represented the people of Sironko town council were Muslims who are known to be a washer, they need water for anal cleansing. Usually, they finish all the activities, defecation and anal cleaning, in one sitting. But, in dry toilets, they have to shift from one place to other for anal cleaning. This is option is only for people who use water for anal cleansing. This leaves the other 76.7% population who use toilet papers and other materials capacity to use the conventional ecosan toilets.

5.2 Recommendations

Here are some recommendations for the improvement of present ecosan toilets and improvements in future.

- Awareness generation among people of Sironko, activists and political level is strongly needed. The level of awareness at present is found insufficient.
- Mass campaigning for the improvement and expansion of ecosan toilets is necessary.
- The IEC materials for the promotion and use of ecosan toilets reflecting the local situation is lacking. More audiovisual and printed materials on the topics are necessary.
- The major principles of ecosan toilets should be disseminated to school and college-level students.
- A central collection system of urine and faeces should be developed so that the household without agriculture fields can also use the ecosan toilets.
- The concept of trading in urine and faeces should be developed. Commercialization of nutrients of excreta is necessary.
- Water-saving parts of the ecosan technology should also be highlighted among the users.
- Environment protection should be the focus of all sanitation programs.
- More research on the sanitization of faeces should be done to find out the effective and easy way of sanitizing the excreta.
- Research on reducing the volume of urine also seems necessary. Reduction of volume of urine may be the best way to ease the transportation of urine.

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APPENDICES

Appendix 1: BUDGET

A budget is a list showing estimated expenditures for the research presented in the table below.

S/N	Description	Unit	Quantity	Rate (UGX)	Amount (UGX)
1	**Stationary**				
1.1	Photocopy (Assessment forms)	item	6	200	1,200
1.2	Flash Disk 128GB	No.	1	30,500	30,500
1.3	Printing (Questioners, Proposal)	Pages	100	100	10,000
2	**Sampling / Collection**				
2.1	Local Lugisu Translator	Days	7	5,000	35,000
2.2	Refreshment	Item	7	2,000	14,000
3.0	**Transportation**	item	2	50,000	100,000
4.0	Others				20,000
	GRAND TOTAL	**NA**			**190,700**

Table 2: Proposed Budget *Source; personal estimates*

Appendix 2: QUESTIONNAIRE

Introduction

Dear respondents**,**

This is to humbly request you complete the attached questionnaire that will enable the researchers to examine the performance of the conventional tip latrines and the techniques and ease of maintenance. Please be assured that the information you give will be treated with the utmost confidentiality and is strictly for academic purposes, kindly respond candidly.

NDYAMUBA VICTOR

Researcher

Questionnaire Number | | |

Section A: Demographic characteristics

Please fill in the box the code corresponding to the most appropriate choice

1. What is your gender?

Male		Female	

2. What is your age?

Below 20		20 to 30		31 to 40		41 to 50	

51 to 60		61 and above	

3. What is your religion?

Anglican		Catholic		Muslim		SDA	

Others (specify)…….

4. What is the highest level of education you have attained?

None		Primary		Secondary		Vocational		University	

5. Do you have a toilet/pit latrine at home?

Yes		No	

6. How many are you in the family?

……

7. Do you experience challenges in using the pit latrines during rainy seasons?

Yes		No	

8. Have you ever heard of an Ecosan toilet?

Yes		No	

If "Yes", do you know how to use the ecosan toilet?

Yes		No	

9. Do latrines in the community collapse in rainy seasons?

Yes		No	

SECTION B: Conventional Pit Latrine

Challenges encountered in the use of the pit Latrine

1. Level of comfortability

Please tick the box that is most appropriate (√)

5=Very high, 4=High, 3 Average, 2=Low and 1= Very low

S/N	**Items**	**5**	**4**	**3**	**2**	**1**
1	Splashing of water from the pit latrine while in use.					
2	Bad odour in the vicinity of the latrine.					
3	Privacy while in use.					
4	Flies inside the latrine.					
5	Cleanliness.					

2. Height of water table

Please tick the box that is most appropriate (√) tick one choice.

S/N	Items	YES	NO
1	Our pit latrine is deep (more than 3m)		
2	Increases volume of faecal matter.		
3	Makes it hard to line pit walls.		
4	Our pit latrine is constructed as a permanent structure		
5	Is groundwater contaminated?		
6	Collapsing of pit walls		

3. Life span

Please tick the box that is most appropriate (√)

5=Very high, 4=High, 3 Average, 2=Low and 1= Very low

S/N	Items	5	4	3	2	1
1	Rate at which pits are filled up.					
2	Recurring initial costs					

4. Nature of the soils

Please tick the box that is most appropriate (√)

5=Strongly agree, 4=agree, 3 Not sure, 2=Disagree and 1= Strongly disagree

S/N	Items	5	4	3	2	1
1	Causes collapsing of pit walls					
2	Doesn't allow excavation of deep pits					
3	Doesn't facilitate construction of permanent pit latrines					

5. Health

Please tick the box that is most appropriate (√) tick one choice.

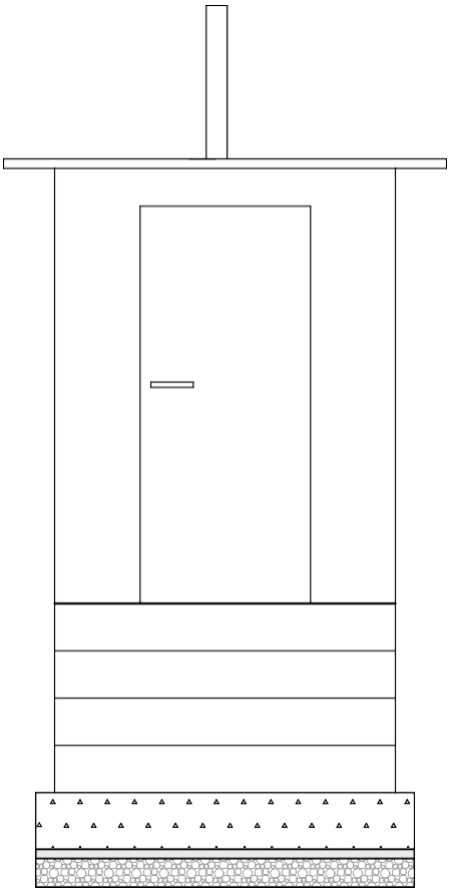
S/N	Items	YES	NO
1	Contraction waterborne diseases		
2	Poor hygiene of the floor		
3	Diseases spread by flies (cholera, dysentery and typhoid)		

SECTION C: Anal cleansing material

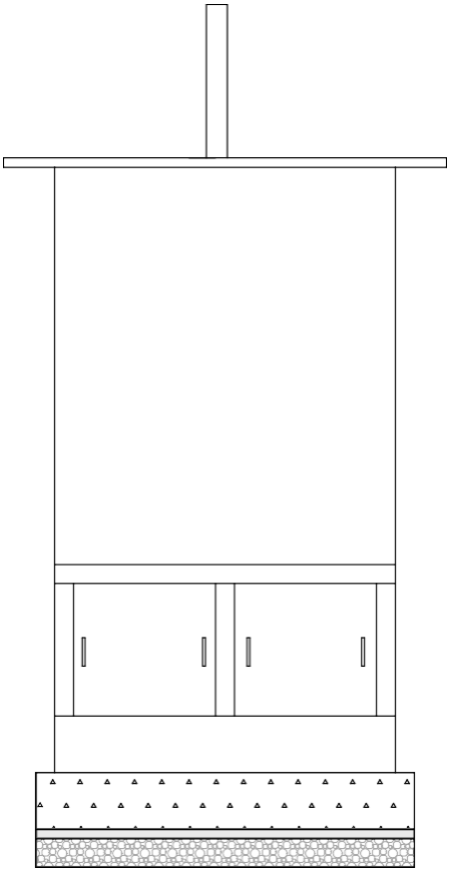
Please tick the box that is most appropriate (√) tick one choice.

S/N	Items	YES	NO
1	We use toilet papers as anal cleansing after using the toilet		
2	We use water as an annual cleansing material		
3	We use paper/ Newspaper as anal cleansing material		
4	We use leaves as annual cleansing material		

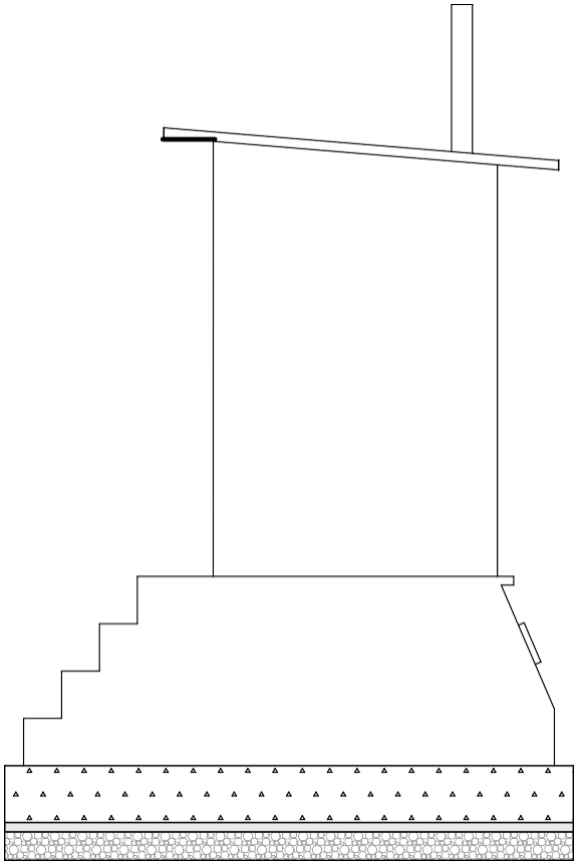
THANK YOU.



Front view



Back view



Side view

ELEVATIONS OF THE PROPOSED ECOSAN TOILET

Drafted by

Victor

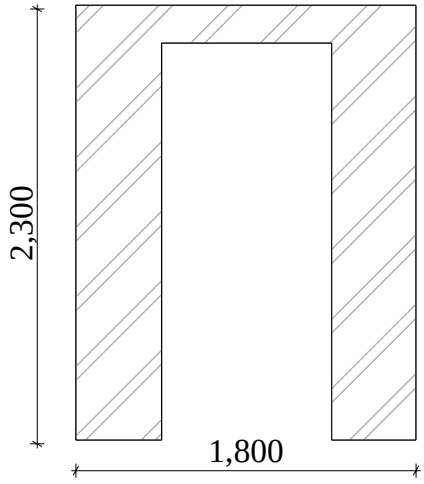
Checked by

Mr. Tom Mukasa

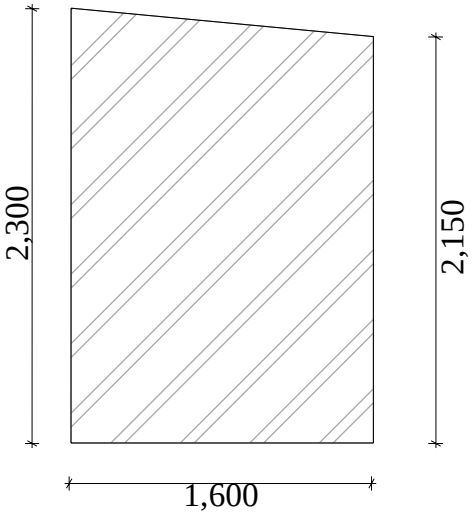
Drawing scale

1:40

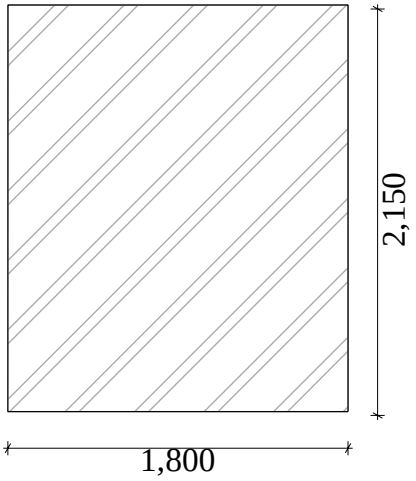
SUPER STRUCTURE



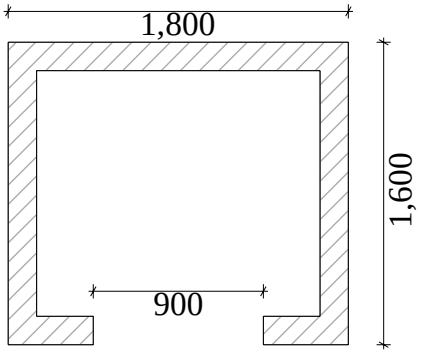
Front view



Side view

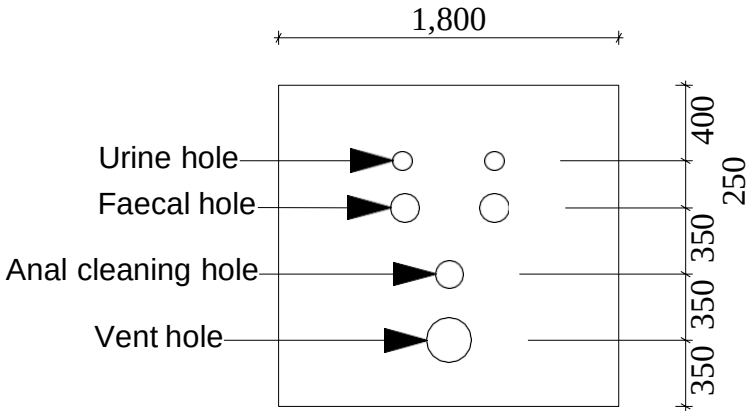


Back view



Plan view

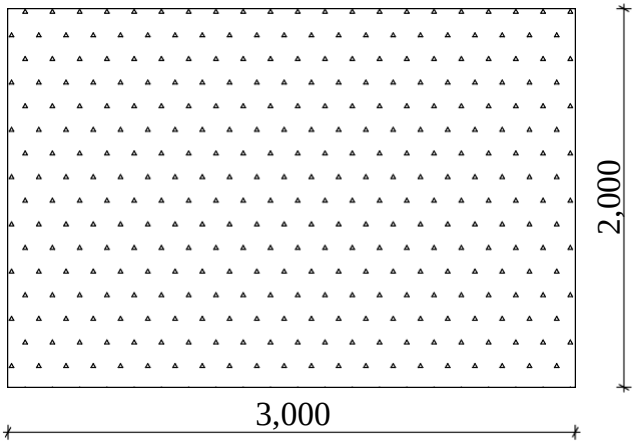
TOP FLOOR SLAB



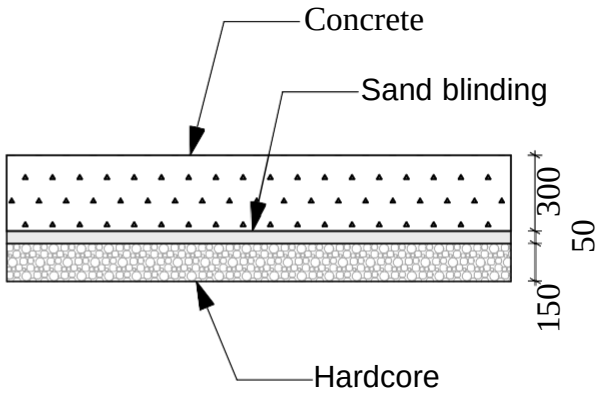
Plan view

DRAWING OF SUPER STRUCTURE AND THE TOP SLAB OF THE PROPOSED ECOSAN TOILET
Drafted by **Victor**
Checked by **Mr. Tom Mukasa**
Drawing scale **1:40**

BOTTOM SLAB

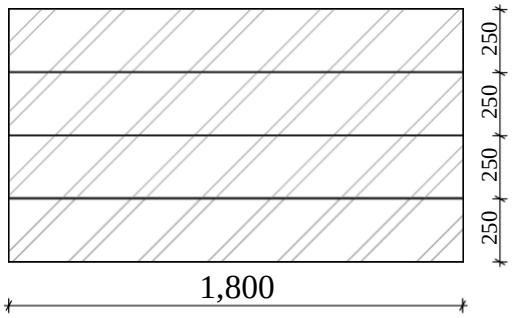


Plan view

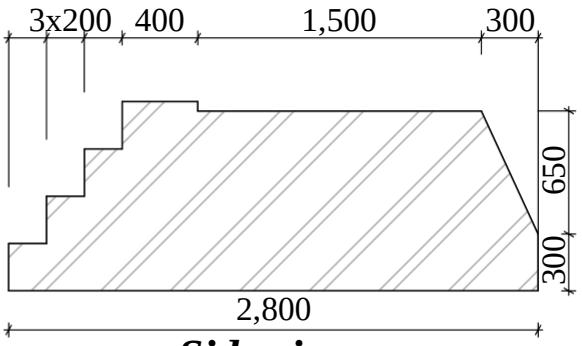


Side view

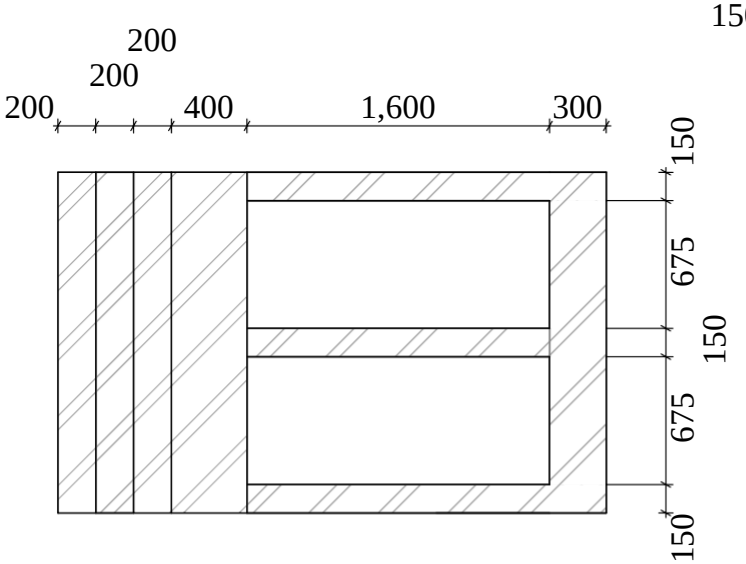
STORAGE COMPARTMENTS



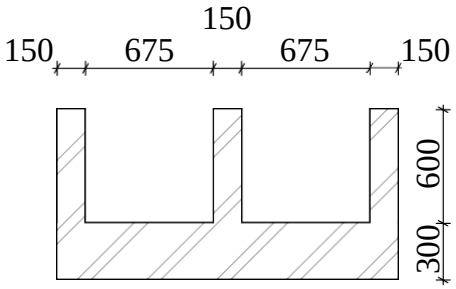
Front view



Side view



Plan view



Back view

DRAWING OF BOTTOM SLAB AND STORAGE COMPARTMENTS OF THE PROPOSED ECOSAN TOILET	
Drafted by	**Victor**
Checked by	**Mr. Tom Mukasa**
Drawing scale	**1:40**