LAHDEN AMMATTIKORKEAKOULU
Lahti University of Applied Sciences

CHOOSING A DRY TOILET MODEL FOR PUBLIC USE

Case: Ho Central Market, Ghana

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Emilia Osmonen

Lahti University of Applied Sciences
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ABSTRACT

The aim of this Bachelor's Thesis was to study the suitability of the existing institutional dry toilet model at Ho Municipality for public use at Ho Central Market. The technical design and management model of the public facility were defined and recommendations for modifications were made.

The study was done for Lahti Region Development LADEC Ltd, which is implementing a North-South Local Government Co-operation between the City of Lahti and Ho Municipality. Through the cooperation, four institutional dry toilets have been implemented in the Ho Municipality. As further step on the project, the feasibility of the dry toilet model for public use was to study.

The research was based on a literature analysis as well as the results of the dry toilet project at Ho Municipality. In addition, the research included interviews of the Ho Municipal Assembly's officers and interviews of the employees of public toilet facilities in Ho Central Market carried out during the practical training period in Ghana.

To enable the usability of the institutional dry toilet model in public use, modifications for the technical design and a new approach to the administrative model were recommended. The off-site treatment of the toilet waste was found more suitable option in public use. Modifications in the technical designs of using the facility were also recommended, to improve the user convenience. A new administrative model was introduced and further actions were recommended.

The institutional dry toilet model is not suitable for public use in the form that it is currently implemented in Ho. However, the dry toilet technology can be applied to a public toilet facility with the recommended modifications and the sustainable administrative model.

Key words: ecological sanitation, dry toilet, public toilet, Ghana

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TIIVISTELMÄ

Opinnäytetyön tarkoituksena oli selvittää Hon kunnan alueelle esitellyn kuivakäymälämallin soveltuvuutta yleisökäymäläksi. Yleisökäymälän soveltuvuutta tutkittiin Hon kunnan keskeiselle torialueelle. Yleisökuivakäymälän soveltuvuuteen määriteltiin rakenne sekä palvelun ja huollon vaatimukset, joiden perusteella suositeltiin vaadittavat muutokset.

Toimeksiantajana toimi Lahden Seudun Kehitys LADEC Oy, joka toteuttaa Lahden kaupungin ja Hon kunnan välistä Pohjoisen ja etelän kuntien yhteistyöohjelmaa. Hon kunnan alueelle on rakennettu neljä kuivakäymälää yhteistyön aikana. Yhteistyön tavoitteena on laajentaa kuivakäymäläteknologiaa projektin jatkuessa, minkä vuoksi kuivakäymälän soveltuvuutta yleiseen käyttöön tutkittiin.

Opinnäytetyö perustuu kirjallisuustutkimukseen, jonka aineistona on käytetty kuivakäymäläpilottien tuloksia ja alan kirjallisuutta. Ghanassa suoritetun työharjoittelu aikana toteutetut Hon kunnan paikallishallinnon viranomaisten ja Hon kunnan keskeisen torialueen yleisökäymälöiden työntekijöiden haastattelut täydentävät aineistoa.

Kuivakäymälän rakenne ja toteutus vaativat muutoksia, jotta sitä voidaan soveltaa yleiseen käyttöön Hon kunnan keskeiselle torialueelle. Tulosten perusteella off-site-kompostointi ja virtsan off-site-käsittely ovat soveltuvia menetelmiä käymäläjätteen käsittelyyn. Myös tekniseen toteutukseen suositeltiin muutoksia käyttäjämukavuuden parantamiseksi. Yleisökäymälän hallinnointiin esiteltiin uusi lähestymis- ja toteutustapa sekä suositeltiin lisätoimia toteutettavuuden selvittämiseksi.

Hon kunnan alueella käytetty kuivakäymäläpilottimalli ei sovellu julkisesti käytettäväksi. Kuitenkin pilottimallissa käytettyä tekniikkaa voidaan soveltaa yleiseen käyttöön tulevaan kuivakäymälään ehdotettujen muutosten ja kestävän hallinnointimallin hyväksymisen jälkeen.

Asiasanat: ekologinen sanitaatio, kuivakäymälä, yleisökäymälä, Ghana

CONTENTS

TERMS AND ACRONYMS

AFD	Agence Francaise de Development
CWSA	Community Water and Sanitation Agency
DT	Dry Toilet
ECOSAN	Ecological Sanitation
EHO	Environmental Health Officer
EHU	Environmental Health Unit
GUMPP	Ghana Urban Management Pilot Programme
GWCL	Ghana Water Company Limited is a publically-owned water infrastructure asset holder which, along with Ghana Urban Water Limited, is mandated to supply urban areas in Ghana.
HMA	Ho Municipal Assembly
KMA	The Kumasi Metropolitan Assembly is the city authority. The Waste Management Department has overall responsibility for the provision and management of sanitation facilities.
KVIP	Kumasi Ventilation Improved Pit
MESSAP	Municipal Environmental Sanitation Strategy and Action Plan
MLGRD	Ministry of Local Government and Rural Development of Ghana
SHC	School Health Committee
SHEP	School Health Education Programme
STL	Septic Tank Latrine
UDDT	Urine Diverting Dehydration Toilet
VIP	Ventilation Improved Pit
VVU	Valley View University
WC	Water Closet
WSUP	Water & Sanitation for Urban Poor. WSUP Programme works with service providers to demonstrate and scale up successful models to improve services for low income consumers.

1 INTRODUCTION

The global sanitation target of Millennium Development Goals is to reach 75 per cent improved sanitation coverage by 2015. Many countries are unlikely to reach the target, including countries of sub-Saharan Africa, but encouraging progress is being made. (UNICEF/WHO 2012, 14.) Ho Municipality has taken many steps to improve the sanitation status of the municipality but has still struggled with the same challenges that UNICEF/WHO (2012) has identified with growing population and the infrastructural development. Furthermore, the solid and liquid waste management systems are insufficient and the lack of adequate sanitation facilities as well as open defecation is causing environmental and health risks. (Aalto, Järvelä, Kauhanen, & Mäkelä 2012). The use of shared sanitation facilities is common in sub-Saharan Africa, including Ghana. It is predominantly an urban phenomenon, which offers remarkable relief in the areas where private latrines are not financially possible to build for every household. (UNICEF/WHO 2012, 21.)

There is a real necessity for developing sanitation in Ho Municipality as the baseline study made in 2012 as a part of the Municipal Environmental Sanitation Strategy and Action Plan (MESSAP) reveals. The number of private latrines as well as the number of public latrines is inadequate even though the majority of people use public latrines. The Ho Municipality's target for sanitation coverage is 70 per cent and with the current population development more latrines need to be built to achieve the target by 2015. As the estimated population in 2015 will be 303 973, the number of private and public latrines should be 21 278 to meet the target of the Millennium Development Goals (HMA 2012, 20.) Ho Municipality has also included the dry toilet technology introduced to Ho through the North South Local Government Co-operation project into the MESSAP.

Dry toilet technology was introduced to Ho through the North South Local Government Co-operation between Ho Municipal Assembly and City of Järvenpää in 2007. Since 2010, Ho Municipal Assembly has engaged with the City of Lahti to continue the cooperation as part of the North South Local Government Co-operation Programme. The programme is funded by the Finnish Ministry of Foreign Affairs and it is coordinated by the Association of Finnish Local and Regional Authorities. The cooperation project focuses on

environmental aspects and it is implemented by the Lahti Region Development LADEC Ltd. As there is a real interest in the dry toilet technology, the promotion of ecological sanitation and the evaluation studies on the suitability of the dry toilet models to the conditions of Ho is continued through the cooperation project.

Through the North-South Local Government Co-operation project, Ho Municipality has had the opportunity to provide institutional dry toilets for four schools in Ho Town. As the dry toilet provides an ecologically and socially sustainable option for the sanitation in institutional settings, the system could help to address the pollution of water sources, reduce the outbreaks of waterborne diseases, improve the production capacity of agriculture and increase social equality. To have a wider understanding of the feasibility and the possibilities of dry toilet technology in conditions of Ho, more information is needed.

The aim of this Bachelor's Thesis is to find a suitable public dry toilet model for Ho Central Market. The study is developing the current institutional dry toilet model existing in Ho Municipality by evaluating the functionality of the facility as well as by analyzing the need of changes to the technical solutions for public use. In addition, the different administrative models in public settings are also studied. The research questions are:

- What would be a suitable dry toilet model for public use in Ho Central Market?
    - Would the institutional DT model be a suitable model for public use?
- What would be the best way to organize operations and maintenance of a public dry toilet facility in Ho Central Market?

The results of this study are based on a literature analysis and interviews. The interviews of the Ho Municipal Assembly officers made in August 2013 and their point of views which came out during the workshops arranged in year 2013 have been used as a one part of the research source. A development plan of the Ho Central Market area and the study of the state of the sanitation in Ho Municipality as well as other strategic plans of the Ho Municipality constitute the other base line of the research source. Legal requirements of Ho Municipality also need to be

taken into consideration. While studying the administrative model of public dry toilets, the lessons from the other sanitation solutions in public settings need to be considered. During my work placement period in the Environmental Health Unit of Ho, I carried out a survey of the sanitation status in Ho Central Market and assessed the challenges of the technical model as well as the maintenance and usage of the institutional dry toilet pilots.

While choosing the suitable sanitation model in conditions of Ho, the local sanitation culture and the local resources to maintain and fund the technical solutions have to be considered. Hence, it is not relevant to research and examine studies of sanitation alternatives extensively or world-wide. It is more vital to examine the study area and local sanitation culture and thus this case study concentrates mainly on the results of the local sanitation studies and takes widely into consideration the special features of the study area and local conditions.

2 SANITATION AND PUBLIC TOILETS IN HO CENTRAL MARKET

To have a comprehensive picture of the sanitation situation in Ho and in Ho Central Market the local sanitation practices, climate conditions and estimations of population growth will be presented below. The current situation of public toilet facilities in Ho Central Market is also examined to find out the existing challenges of the technical solutions and required maintenance actions. Especially the maintenance model needs to be studied to understand the local resources and standards of maintaining the facilities. These challenges and good practices provide guidelines for the design the maintenance model of public dry toilet in Ho Central Market. Renovation plans made to the Ho Central Market area provide a good opportunity to upgrade also the sanitation status in the area as a whole.

The information on the public toilet facilities in Ho Central Market is based on, first and foremost, the interviews made during the site visits to public toilet facilities in August 2013, with the assistance of Ho Municipal Assembly's Environmental Health Assistants Mr Gideon Amegbor and Ms Sarah Zottor, but also on my own observations (Appendix 2).

2.1 Ho Municipality

The Ho Municipality is one of the 18 districts in the Volta Region of Ghana (HMA 2010, 1). Ghana lies in West Africa near the equator between Togo and Ivory Coast (FIGURE 1) and Ho Municipality in south-eastern Ghana in the Volta Region (HMA 2010, 1) (FIGURE 2). Ho is the municipal capital as well as the regional capital (MLGRD 2010a, 15).

FIGURE 1. Location of Ghana (Lahti-Bojana-Ho 2014)

FIGURE 2. Location of Ho and Ghana

The climate is generally tropical with regional variations in humidity and temperature levels. Generally, temperatures are high throughout the year, which enables good conditions for plants and food crop farming. In effect, mean monthly temperatures range from 22 °C to 32 °C in the municipality while annual mean temperatures range between 16.5 °C and 37.8 °C. However, during the dry season daily temperatures rise so high that irrigation for food crop cultivation should take place. (HMA 2010, 1.)

According to the Ghana Statistical Service (2012), the population of Ho Municipality in 2010 was 271 881. The population of the capital Ho was estimated to be 84 066 in 2010. 63 % of the population live in rural areas while the rest 37 % of the population live in the three main towns of the municipality: Ho, Tsito and Kpedze. (HMA 2010, 7.) Ho is the only fast growing urban centre in the municipality with 3.1 % growth rate, which is more than the national figure of 2.6 % and regional average of 1.7 %. The average annual population growth

rate in the municipality is 1.17 %, which is lower than national growth rate. These growth rates reflect that people are leaving the rural area and the households are centralizing to Ho. (HMA 2010, 8.)

Agriculture is the main factor in the economy of the Ho Municipality's. It employs about 70 % of the economically active labour force in the municipality, which makes it the main source of livelihood in Ho Municipality. Furthermore, nearly every household in the municipality is a small-scale agriculture. (HMA 2010, 42.) The service and commerce sector is the second biggest employer, as it employs about 22 % of the local active labour force. The retail and wholesale of agricultural and industrial goods are dominated the commercial sector. The services sector is dominated by small scale operators in activities such as telecommunication services, hair dressing, electronic and vehicle repairs. The municipality has a number of small scale industries which are widespread but there are currently no large industrial holdings. The small-scale industries include cassava flour processing, mushroom growing, carpentry and metal work. (HMA 2010, 50-51.)

2.2 Sanitation status in Ho

The inadequate situation of sanitation facilities and services is generating open defecation and disorganized disposal of waste in Ho Municipality. Almost half of the population does not have access to a hygienic waste disposal system for toilet waste as the Municipal Water and Sanitation Team of HMA estimated the sanitation coverage of the municipality to be only 46 % in 2011. The lack of a centralized sewerage system and a wastewater treatment plant is causing contamination of groundwater supply and other environmental health risks. (Järvelä, 2012, 23; 43.) There is some uncertainty on the numbers of latrines, depending on the references and calculation methods.

In Ho Municipality, 22.4 % of the households have a toilet facility, which means 6 766 private toilet facilities (HMA 2012, 22). There are three main toilet facility models existing in households in the district: Water closet (WC) 67 %, Kumasi Ventilated-Improved Pit latrines (KVIP) 16.4 % and Ventilated-Improved Pit latrines (VIP) 9 %. According to Ho Municipal Assembly (2012), the use of pit

latrines and KVIPs should be discouraged in private premises in urban areas since Ho is the regional and municipal capital.

The habit of sharing the toilet facility and using public latrines raises the number of the inhabitants' access to the sanitation facility. There are 338 public toilet facilities in Ho Municipality including 38 latrines in Ho Town. The most common toilet facility models for public use are Pit latrines (76 %), KVIP (9.8 %) and WC (6.2 %). 52 % of the public WC facilities are located in Ho Town. (HMA 2012, 19-22.) However, the low level of toilet facilities is the central reason for the general practice that people are still practicing open defecation also in urban areas (HMA 2010, 41; Järvelä 2012, 23).

The waste management, including the disposal of both solid and liquid waste, is not carried out with satisfactory operations in Ho Municipality (HMA 2010, 41). Due to the lack of a centralized sewerage system, the public toilets are mostly non-water based. However, they are not operated in this way in public settings. The sludge from KVIP as well as from septic tank and WC latrines is being disposed to the final disposal site without treatment even though the KVIP is designed to treat the toilet waste in the facility. (Järvelä 2012, 43.)

There is only one septic emptier in the municipality for both of the toilet facility service providers, the private sector and the Assembly. This has caused challenges for the timely and regular disposal of human excreta (HMA 2010, 41-42) and, moreover, there are health risks and environmental health risks due to the lack of adequate emptying of the septic tanks. Ho Municipal Assembly manages 50 % of the total faecal sludge management while the remaining 50 % is managed by the private sector contractors (HMA 2012, 32).

In addition to inadequate waste and sanitation management and the number of sanitation facilities, the lack of a landfill site is causing challenges in Ho Municipality. The old landfill site was closed in 2011 and currently the solid waste is disposed to a temporary refuse dumping site in Hoviefe. The liquid waste including sludge from toilet facilities is transported to the site on Accra Road. (Kettunen & Osmonen 2013c.) Ho Municipal Assembly is in the middle of the acquisition process for a new engineered landfill (Ahiagbede 2013).

2.3 Public toilet services in Ho Central Market

Ho Central Market is the major market area in Ho Municipality. The market place is used every day but the main market day is arranged on every fourth day and the usage of the area rises significantly on these days. In addition to the market services, the area also offers ancillary services including sanitation facilities, a lorry park and a trotro-station and storage and education house. The use of the public toilets in the area is remarkable when considering the number of market place vendors and customers as well as the drivers and passengers of the trotro-station. The cleaners of the market place and inhabitants nearby also use the toilet facilities, especially in the morning and evening. (Zottor 2013.)

In the market area, there are three public toilet facilities which also offer washing facilities. Two of the facilities are septic tank latrines (STL) and one is a water closet (WC). Septic tank latrines are managed mainly by Ho Municipal Assembly and the water closet by the private sector with the assistance of Ho Municipal Assembly (Ahiagbede 2013).

Public toilet services are currently inadequate as the capacity of the toilet facilities has been calculated years ago and the population has grown significantly during the years. Furthermore, the condition of the toilet buildings and supportive functions such as hand washing facilities has degenerated over the years. Based on my own observations and interviews done during the site visit in Ho Central Market, due to these factors the facilities are causing not only environmental health risks to the surrounding environment and water supplies but also health risks to the market place vendors and the inhabitants nearby.

2.3.1 Technical models

Public toilet facilities in the Ho Central Market area differ from each other in technical design and solutions. The septic tank latrines are designed to function without water unlike the water closet. However, both of the models are connected to the septic tanks to collect the toilet waste. Even though there are three public toilet facilities, the capacity of all of them is not adequate for the current usage in the market area. This has also been a consequence of inadequate maintenance,

which has been studied in the following Chapter 2.3.2 Service and operational models. As the facilities have been used for years and the maintenance actions have been inadequate and maintenance intervals too long, they are not currently functioning properly. (Zottor 2013.)

The two septic tank latrines and the separated urinal building are located next to each other at the market area (Appendixes 3 and 4). The oldest public toilet facility is the STL where there are five squatting pans and a drain urinal on the female and male sides. (Komla 2013.) In the newer STL, the number of the squatting pans has been doubled, so there are 12 squatting pans on both sides of the facility, but there are no urinals. Urinals for both sexes are located in a separated facility next to the STL. (Gakogoe 2013.) Squatting pans and female drain urinals are commonly used in the public toilets as well as in the household models in Ho Municipality. The STLs do not use water and there is no running water. For the hand washing facility, there is a water container for the customers in the yard. (Gakogoe 2013; Komla 2013.)

In all its simplicity, the toilet waste from the STL is led to the septic tanks. The capacity of the septic tanks was observed to be inadequate during the site visits with the Environmental Health Assistants Mr Gideon Amegbor and Ms Sarah Zottor. The urine from the urinals should be led to the septic tanks, but unfortunately there is no sufficient urine collection system and the urine is flowing to the ground. Ho Municipal Assembly is planning renovations for this problem. (Zottor 2013.)

The latest public toilet facility built at central market is the water closet latrine (Ahiagbede 2013; Appendix 5). The toilet building is separated to the female and the male sides. There are four toilet rooms and one drain urinal for female users and five toilet rooms and two urinals for male users. In the middle of the toilet building there is a storage room. (Tagbor 2013.) To work properly, the WC requires piped water connection. As everywhere in the municipality, also in the central market area piped water connection was occasionally cut off. (Järvelä 2012, 56.) Water for the facility is also collected with the polytank, but as it gathers only rain water, it has to be noticed that the rain water is not adequate for the functioning of a public WC latrine, especially in dry season.

The public WC latrine is connected to the septic tank, like the WCs in the municipality generally. The septic tank system consists of two watertight chambers and a third chamber with infiltration bed. Wastewater flows through the two chambers, where the solid waste settles and in the last chamber the effluent percolates through to the ground. (Järvelä 2012, 40-42.) In the market area, the system with inadequate septic tank capacity has currently caused environmental and health risks in the area to such an extent that there has been a need to close the surrounding market services (Fugar, 2013).

In Ho Central Market, the number of the public toilet facilities is currently inadequate and the function of the toilet models is not updated. Septic tanks do not treat the sludge in a satisfactory manner and, furthermore, the capacity of the septic tanks is not adequate for the current emptying cycle. (Järvelä 2012, 12.) The sludge is transported with the cesspool emptier to the temporary disposal site while the new disposal site is under construction (Järvelä 2012, 41).

2.3.2 Service and operational models

The administrative models of the public sanitation facilities are remarkable factors in the operation of the facilities in Ho Central Market. The service models of the facilities do not differ in administrative models or technical models but there are differences in the number of employees. (Gakogoe 2013; Komla 2013; Tagbor 2013.) The number of customers is much more than the facilities are able to tolerate with the current operations (Zottor 2013).

There are two different administrative models of the public toilet services in the market area. Two oldest sanitation facilities are operated by Ho Municipal Assembly and the latest public toilet facility is operated by the private sector. The public toilet facilities are constructed by HMA and the private sector has bought the WC facility. The private sector is also paying a rent to the Market Queen. (Ahiagbede 2013.)

Both of the STLs are operated by Ho Municipal Assembly and therefore, the maintenance of the facilities is the responsibility of HMA. The minor maintenance costs are covered with the fees of the facilities but the major maintenance actions

need renovation plans for the funding of the maintenance costs from HMA. (Gakogoe 2013; Komla 2013.) According to the Environmental Health Assistant Ms Zottor (2013) and the maintainers of the STLs, Ms Gakogoe and Mr Komla (2013), the main challenge of the maintenance of the facilities is the slow bureaucratic funding system of the HMA. As the HMA is not able to respond to the technical problems as quickly as it should, the problems have grown or even caused other challenges including health risks (Zottor 2013).

The private sector is operating the public WC latrine at the central market. The private sector collects the fees, but also the HMA requests a percentage of the fees. All maintenance actions are the responsibility of the private sector as well as the payment for the employees. (Tagbor 2013.) It was generally noticeable that the operation of the toilet facility by the private sector was considered a more sustainable administrative model than the operation by HMA (Zottor 2013; Gakogoe 2013; Komla 2013; Tagbor 2013). However, according to the Municipal Engineer Mr Dogbevia, the administrative model of Ho Municipal Assembly is more sustainable and operation of the facilities is easier to monitor. It has to be noticed that the toilet facilities operated by HMA are also the oldest latrines at the central market. These latrines need more renovations than the latest toilet facility because of the degeneration over time.

The public sanitation facilities require personnel for daily operations. The facilities employ people for cleaning, people responsible for collecting fees and people for night watch. The number of employees depends on the size and services of the facility. The smaller STL as well as the WC facility employs only two people: one person for collecting the entrance fees and the other for the cleaning activities. (Komla 2013; Tagbor 2013.) In the other STL, the number of personnel is all together five, including one for night watch, two cleaners and three employees for the entrance fees, but the entire sanitation facility also offers separated urinal and washing facilities (Gakogoe 2013). This sanitation facility operates around the clock every day, while the other facilities are closed during the night hours (Gakogoe 2013; Komla 2013; Tagbor 2013).

The emptying of the septic tanks in Ho is the responsibility of HMA but it has only one cesspool emptier (FIGURE 3). The lack of sufficient number of cesspool

emptiers causes problems for the emptying of the septic tanks in the area (Järvelä 2012, 56). As the cesspool emptier is used all over the municipality, the emptying cycle in Ho Central Market is only once a month (Zottor 2013).

FIGURE 3. Cesspool emptier used in Ho Municipality

During my first site visit with Mr Gideon Amegbor at the central market the septic tanks of the STLs were emptied. After two weeks, during my second visit, it was observed that the septic tanks were full. According to my observations and Ms Sarah Zottor, the Environmental Health Assistant allocated to the Ho Central Market area, the emptying cycle is not adequate as the septic tanks filled up during the two-week period. The system will not work properly and nutrient runoffs may increase, if the tanks are not emptied with regularity as often as it is needed (Järvelä 2012, 56).

According to the Ho Municipal Assembly's Finance Office, the number of public toilet facility users in Ho Central Market is currently 400 per day on an average. The number of users is calculated from two public toilet facilities in Ho from which one is situated in Ho Central Market. The calculation is based on the fees of a six-month period so it needs to be noticed that the number of users varies a lot through the months and days. (Appendix 6.) It needs to be taken into consideration that the population growth is on the increase in the municipality.

Also, the renovations planned for the central market place could increase the number of customers. Therefore, it could be assumed that the number of the users of public toilet facilities is also growing. The number of users rises remarkably in the morning and evening times, when the inhabitants nearby also use the facilities (Komla 2013). On market days, organized every fourth day, it can be observed that the capacity of these three public toilet facilities is not adequate in Ho Central Market (Zottor 2013).

The customer pays a fee for the use of the facilities. The facilities managed by HMA costs 0.1 Ghana cedi (GHS) for every use. (Gakogoe 2013; Komla 2013.) The private sector charges two different fees depending on the usage: Use of the urinals costs 0.1 GHS and otherwise the fee is 0.4 GHS. It has been observed that two different fees have been difficult to control. (Tagbor 2013.)

2.4 Renovation of the Ho Central Market area

The Ministry of Local Government and Rural Development of Ghana (MLGRD) has requested Agence Francaise de Development (AFD) to support the formulation and implementation of its urban management policy in the country's main cities as well as the piloting of a "Municipal Contract" system. The Ghana Urban Management Pilot Project (GUMPP) is currently being piloted in selected Metropolitan and Municipal Assemblies including Ho Municipality. The project has started with the assessment of an urban and technical audit, financial audit and organizational audit of the Ho Municipal Assembly. As a consequence of the assessment, the preparation of priority investment programs for implementation under the GUMPP was carried out. (MLGRD 2010a, 7.)

The commercial activities of Ho Municipality take place mainly in the Ho Central Market (FIGURE 4) and the area is also the origin and destination of vehicular and pedestrian traffic especially on the market days. Ho Municipal Assembly charges a flat rate fee per kilogram of product for sale, thus setting the market area in an important position of economic base for Ho Municipality. The congested situation in the area is currently slowing down commercial activities and consequently, the Ho Municipal Assembly considers the renovation of the Central Market area. (MLGRD 2010a, 18.)

FIGURE 4. Market area on market day (Knuuttila 2013)

The objective of the rehabilitation of the Ho Central Market is to redevelop the market area to meet the contemporary requirements of market systems (MLGRD 2010a, 88). The market area will provide a focal point for interaction between the people and marketing and a more hygienic environment with environmental guidelines of the Assembly (MLGRD 2010a, 74). The Ho Central Market is planned to be an ultra-modern facility with provision for warehousing, retail, shopping and ancillary facilities including sanitary facilities (MLGRD 2010a, 77; MLGRD 2010b, 9).

As a result of the assessment of the urban audit, the inadequate level of waste management system has been verified and the lack of properly engineered final disposal site has been highlighted (MLGRD 2010a, 32). Consequently, the construction and management of an engineered landfill site has been identified as one of HMA's prioritised development projects (MLGRD 2010a, 98). It was recommended to construct a final landfill disposal site with a recycling and compost plant to process solid waste generated within the Ho Municipality (MLGRD 2010a, 77). The project is intended to provide capacity for sanitary disposal of waste in the Municipality and thus improve environmental and health

issues. In addition to these environmental improvements, the compost plant will provide compost for agriculture. (MLGRD 2010a, 98.)

The renovation of the Ho Central Market enables also the improvements to the public sanitation facilities which are in line with the Ho Municipal Assembly's environmental guidelines. The contraction of the engineered landfill site with compost plant offers an opportunity to create a public dry toilet facility with an off-site composting system.

3 DRY TOILET PILOT IN HO MUNICIPALITY

The dry toilet pilot project in Ho Municipality is described here to provide background information of the institutional dry toilet model in Ho Municipality and the lessons learned concerning the suitability and sustainability of the ecological sanitation concept in the conditions of Ho. Observations and data on the institutional urine-diverting composting dry toilet (UDDT) are based on my studies conducted as a part of the student work placement in the Environmental Health Unit of Ho. In addition, other research work on the Ho DT pilot has been utilized.

The dry toilets in Ho are designed to be suitable for school environments but there could also be found several technical solutions for a public dry toilet model. Also, the maintenance of the dry toilet and organizing the maintenance should be studied to provide a knowledge of the required actions for proper functioning of the dry toilet facility.

3.1 Ecological sanitation

The dry toilet model in Ho obeys the principles of ecological sanitation. Ecological sanitation includes all three sections of sustainable development as it considers development in social, economic and ecological aspects (O'Neill 2012, 12). Ecological sanitation techniques take into consideration the cleanliness and safety of the surrounding environment as well as decrease the contamination of the environment (Huuhtanen & Laukkanen 2009, 7; O'Neill 2012, 12). It also enables sufficient and safe treatment of excrements and prevents the nutrient runoffs with the principle of nutrient cycle (O'Neill 2012, 12).

The idea of ecological sanitation is based on the natural nutrient cycle. Human excrements are considered a resource rather than waste. Nutrients from faeces and urine are recovered and utilized as a fertilizer and soil enrichment material in food production (FIGURE 5). (Huuhtanen & Laukkanen 2009, 7.) Human faeces are a source of pathogens while urine is usually sterile. Most of the fertilizer value of human excreta is in the urine as well. Urine and faeces can be diverted and treated

separately, and sanitised before they are reused. (Esrey, Gough, Rapaport, Sawyer, Simpson-Hébert, Vargas & Winblad 1998, 4-5.)

The guidelines of ecological sanitation also include avoiding utilisation of water in transportation of excreta and the sufficient treatment of excreta. Faeces and urine are treated primarily on site and then, if necessary, further processed at a secondary composting site which can be located nearby (Huuhtanen & Laukkanen 2009, 7; O'Neill 2012, 12).

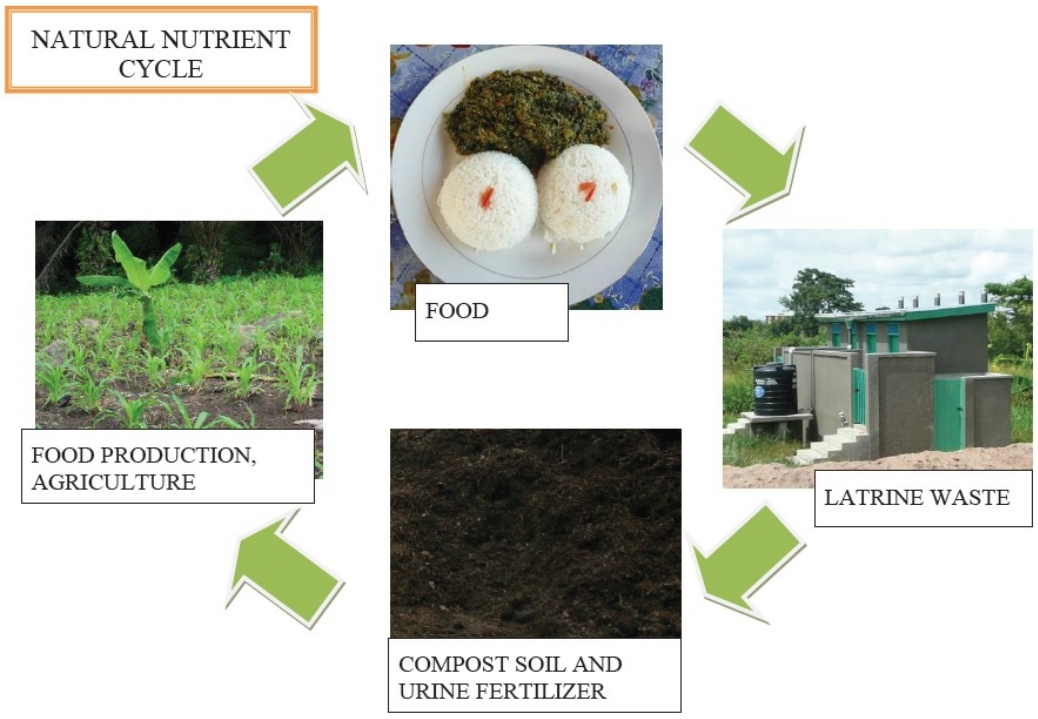

FIGURE 5. Natural Nutrient Cycle (Aalto etc. 2012, 7)

3.2 Institutional dry toilet pilot in Ho

The Municipality of Ho has five dry toilets in schools, of which four have been constructed by the North South Local Government Cooperation project and one private school has implemented the dry toilet technology independently. The Ho Municipality needs to find out solutions for the sustainable sanitation facilities and the dry toilet technology is developed with the principles of ecological sanitation as it provides a hygienic toilet facility and also produces fertilizers for agricultural use (Järvelä 2012, 34). The feasibility of dry toilet technology in Ho was studied by Elina Järvelä who was at the time the project coordinator, with the

assistance of the previous Head of the Municipal Water and Sanitation Team in Ho, Mr Paul Sewor. (Aalto etc. 2012.) The technical design of the dry toilet in Ho is based on the Kumasi Ventilation Improved Pit Latrine (KVIP) with the urine diversion (Appendix 7).

The inadequate sanitation situations in the schools in Ho have encouraged the piloting of the institutional dry toilet model in a school environment (Järvelä 2012, 24). The first dry toilet in Ho was constructed in 2009 at the Regional Model School. The second dry toilet was constructed at the Poly Basic School in 2010. Two dry toilets were constructed in 2012 at Anglican Primary & J.H.S. and Housing Primary & J.H.S. (Aalto etc. 2012.)

The end products from the dry toilet, urine fertilizer and compost, have been tested and compared to artificial fertilizers in field and laboratory conditions. The research was carried out in 2011-2012 by Mr Seth Akah and Mr Cephas Bosrotsi from the Agricultural Engineering Department of Ho Polytechnic. (Aalto etc. 2012.) New field tests have been implemented by Municipal Agricultural Extension office and started in 2013 on seven fields around Ho Municipality. According to Aalto etc. (2012), the results of the field tests in years 2011-2012 and user inquiries have been supportive and encouraging for further promotion of dry toilet model for a sustainable sanitation solution at Ho.

3.2.1 Technical model

The structure of the dry toilet pilot models in Ho is based on a urine-diverting double vault composting system so urine and faeces are collected and treated separately (Aalto etc. 2012, 18, 32). The dry toilets are constructed on top of the ground and therefore can be built in areas where ground waters are close to the surface or the ground is difficult to dig (Paju 2008, 13; Huuhtanen & Laukkanen 2009, 27). In school environments it has been important to divide the facilities in two sections: one for both sexes (FIGURE 6) (Aalto etc. 2012, 33).

FIGURE 6. Dry toilet at Ho Poly Primary School (Aalto etc. 2012, 31)

Due to financial constraints, it was not feasible to construct the dry toilets in line with a recommendation that instructs to provide one toilet room for every 15 girls and one for every 30 boys in school conditions. The dry toilets are constructed approximately one toilet room per 100 pupils but recommendations would have required approximately four times the current number of toilet rooms. (Aalto etc. 2012, 34.)

As the dry toilet facilities should be as durable as possible, water-proof materials like concrete are used to construct the base of the facility (Paju 2008, 13; Huuhtanen & Laukkanen 2009, 27). The compost vaults are made of non-biodegradable material, cement, which makes the vault water-tight. Also to keep sufficient moisture in the vault and to prevent the rain water entering the vault as well as to prevent the possible run-offs from the vault it needs to be water-tight. (Aalto etc. 2012, 33.)

The compost vaults form the lower part of the toilet facility on which the superstructure is constructed. There are two urine diverting squatting pans in every toilet room from which the faeces and material used for personal hygiene

are collected to the compost vaults under the squatting pan and urine is piped to the urine tanks (FIGURE 7). In addition, urine is also collected from the separated urinals. (Aalto etc. 2012, 32; Järvelä 2012, 35.)

FIGURE 7. Urine diverting squatting pan and closed squatting pan

To enable the faecal material to decompose on-site, in the facility, an alternation system is created with the construction of two compost vaults and two squatting pans. (Huuhtanen & Laukkanen 2009, 27.) As can be seen in Figure 7, there are two squatting pans in every room and while one is in use the other one is closed. The compost vaults are also alternated, as presented in Figure 8. The vault under the squatting pan in use is open, while the vault under the squatting pan not in use is closed. While one compost vault is open, the faeces in the other vault have time to decompose. From one toilet room, there is access to two separated compost vaults. Consequently, it is very important to alternate the squatting pans from every room at the same time. (Aalto etc. 2012, 32-33; Järvelä 2012, 35.)

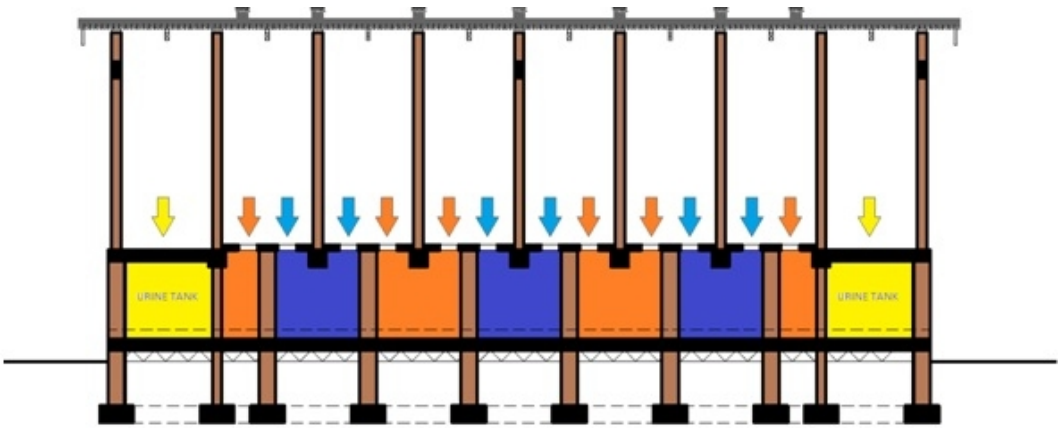

FIGURE 8. The vault alternation system (Aalto etc. 2012, 22)

The composting process needs sufficient ventilation, temperature and right moisture to work in the best possible way. Every compost vault of the dry toilets has been aerated with pipes to enable sufficient conditions for the composting process and also to prevent the odours and smelling. (Aalto etc. 2012, 32.) The pathogens in the faeces are destroyed in the composting process, which takes six to twelve months (Aalto etc. 2012, 17).

There are two different models for urine collection in the pilot schools. The first dry toilet pilot model was built in Regional Model School where the urine from toilet rooms is piped to Jerry-cans at the rear of the toilet building and stored in a separated urine tank. The urine from urinals are piped to the urine tanks on both sides of the toilet building. The urine collection system at Regional Model School is presented in Figures 9.

FIGURE 9. Urine collection system at Regional Model School

To prevent nitrogen evaporation from the urine, it needs to be ensured that the containers where the urine is collected are air-tight (Aalto etc. 2012, 29). In the first dry toilet model, it was observed that the joint between the urine pipe and Jerry-cans was not air-tight enough and the urine collection system needed some

modifications. Also the emptying of the urine from the Jerry-cans to the bigger container for storing was experienced to cause too much workload in the school environment.

In the other three dry toilet pilot schools, the urine from the toilet rooms as well as the urine from the urinals is collected to two tanks on both sides of the toilet building (Appendix 7). The urine tanks are air-tight, thus preventing evaporation and nitrogen loss from the tank during the storage time. Urine needs to be stored for at least a month to sanitise the pathogens due to the rising of the pH level and salt content in the urine (Aalto etc. 2012, 17, 33).

The urine pipes are constructed with two valves, as can be seen in Figure 10. Through the lower valve, the urine enters the urine tank but while the facility is cleaned, this valve needs to be closed to prevent the cleaning water entering the urine tanks. When the lower valve is closed and upper valve is open, the cleaning water flows through the horizontal pipe. (Aalto etc. 2012, 20.)

FIGURE 10. Urine tanks' cleaning valve (Aalto etc. 2012, Annex 8)

The capacity of the compost vaults and the urine tanks is calculated with the average manure and urine production volumes of human being which are 500 litres of urine and 50 litres of faeces per year. The total amount of latrine waste produced in the school environment is estimated to be 1/3 of annual latrine waste production due to part-time use of the facility. To let the faeces to decompose for one year the capacity of the compost vaults are designed for one year excrement production. The capacity of the urine tanks depends on the emptying period but in the dry toilet pilot project they are constructed with the urine tanks of 1 400 litres. (Aalto etc. 2012, 34; Järvelä 2012, 47.)

3.2.2 Maintenance model

To ensure the proper functioning of the dry toilets, it is essential to do certain maintenance actions on a regular basis (Aalto etc. 2012, 19). The structure of the dry toilet takes into consideration the maintenance activities so that the usability of the facility and end products can be ensured (Järvelä 2012, 44). Cleaning the facility, maintaining the compost and the urine collection system are the main maintenance activities, which have the most significant effect on the usability of the facility as well as the urine fertilizer and the compost. Also, the monitoring activities ensure the proper functioning of the facility and ease the assessing of the state of the facility. All maintenance actions are allocated to responsible actors to supervise the maintenance of the facility.

Cleaning activities are the most important actions in keeping the latrine hygienic for the users as well as keeping it functioning. There are some technical functions, which should be done before the facility is cleaned. While the facilities and urine pipes are cleaned it is important to make sure that no cleaning water enters the urine tanks causing dilution of the urine when it is intended as a fertilizer. The urine pipes are equipped with the valves which can be turned off and on before and after the cleaning actions. Thus it can be ensured that cleaning water and also the litter on the floors and urine bowls flows out of the urine collection system. (Aalto etc. 2012, 19-20.)

To decompose the faeces, cleaning material and litter need to be stirred and turned on a regular basis to ensure the optimal airflow and the balance of the nitrogen

and carbons for the composting process. To spread the solid waste evenly in the vaults in use it needs to be turned every month. To let the composting process have time to reach a temperature high enough to exterminate the pathogens, the compost in the vaults not in use is turned only once in two months. These maintenance actions ensure the adequate amount of oxygen and moisture for the optimal conditions of the composting process and also prevent steep heaps from forming under the squatting pan. (Aalto etc. 2012, 21.) Assessing the state of the compost and the optimal conditions of the composting process are also a part of the monitoring.

Currently, the urine tanks are recommended to be emptied three times per year or whenever it is needed. As the schools have a one month holiday after every three-month term, it has been decided to organize the emptying after the holiday while the urine has had time to sanitize for a month. Currently, there are valves on the bottom of the urine tanks where the urine can be emptied to smaller cans. It was also planned that the urine could be sanitized afterwards for a month in the cans before utilizing it. (Aalto etc. 2012, 21.)

The alternation system causes the main maintenance actions which need to be done with special attention. Alternating the compost vaults and squatting pans as well as emptying the mature compost from the vaults are crucial actions that ensures the functioning of the dry toilet. As a consequence of the construction of the dry toilet, the composting process is able to go on while the facility is used (Aalto etc. 2012, 22). To keep the alternation system under control and the right vaults and squatting pans closed, the vaults have to be alternated at the same time. If the solid waste is decomposed thoroughly, it can be emptied and used as a soil enrichment material; otherwise it should be considered if further composting elsewhere would be needed. (Aalto etc. 2012, 22-23.) If the capacity permits, the emptying period and alternation cycle should be once a year to ensure that the compost has had adequate time to mature.

Monitoring the state of the toilet facility is the most effective way to ensure the usability of the dry toilet´s end products with the least resources needed. To avoid any kind of errors in the functioning of the dry toilet, the urine collection system and the compost vaults need to be assessed on a regular basis. (Aalto etc. 2012,

20.) In addition, the surface level of the urine tanks needs to be monitored to anticipate the need for emptying. The composting process needs assessing once in a while to control the amount of litter and humidity. (Aalto etc. 2012, 19-21.)

3.2.3 Organizing the maintenance of the dry toilet

The schools have formed the School Health Committees (SHC) to organize the facility management of the dry toilets. The responsibilities of the maintenance of the dry toilet and the user education are shared between the SHC members. (Aalto etc. 2012, 19.) The Municipal Assembly has also allocated the Environmental Health Officers (EHO) to assist the schools on the technical issues of the dry toilet. The Ho Municipal Assembly's Environmental Health Unit (EHU), the Municipal School Health Education Program (SHEP) Coordinator and Agricultural Extension Officers provide support on proper and safe maintenance and usage of the dry toilet as well as the utilization of the end products. (Järvelä 2013.)

The School-based SHEP Coordinator has also the responsibility for the maintenance of the facility and for informing the Municipal SHEP Coordinator on maintenance actions of the dry toilet. The Municipal SHEP Coordinator and EHO are responsible for monitoring the maintenance of the facility and organizing the user education of the teachers and users with the assistance of the School-based SHEP Coordinator (Aalto etc. 2012, 13-14, 19; Järvelä 2013.) The main role of the Municipal SHEP Coordinator and EHO is to facilitate the formation of the SHC and support the schools with the facility management (Järvelä 2013.)

All the maintenance actions which need more resources such as emptying the urine tanks and compost vaults have been organized with the assistance of the Municipal Assembly and the Agricultural Extension officers. When it is time to empty the urine tanks and empty and change the composting vaults, the school informs the EHO who will contact Agricultural Extension Office. Agricultural Extension Office will organize the distribution of the urine and the compost to the farmers and is responsible for organizing the storing of the urine for one month. (Aalto etc. 2012, 21-23; Järvelä 2013.)

3.2.4 Suitability of the dry toilet for Ho Municipality

The suitability of the dry toilet for Ho Municipality has been studied during the cooperation years. Ms Järvelä (2012) has studied the topic more specifically in her Master's Thesis from ecological, economical, technical and socio-cultural aspects. The results of the studies have been mostly encouraging, despite of the fact that the design and maintenance of the dry toilet are unfamiliar techniques and methods in the area. DT offers a sustainable alternative to toilet waste management with on-site treatment and re-use of the toilet waste as a fertilizer but it is an environmental-friendly sanitation facility only if it is used and maintained according to its design (Järvelä 2012, 49).

Currently the unsafe disposal of sludge from septic tanks and KVIPs and the sludge overflowing from the tanks are producing environmental and health risks in Ho Municipality (Järvelä 2012, 53). The diversion of the urine keeps the pathogenic solid waste dry and the water-tight vault prevents leakages to the soil and groundwater in contrast to other common toilet facilities in Ho Municipality and thus protects the environment (Järvelä 2012, 44). In addition, the use of human waste as fertilizer would ease the problems in the centralized waste management in Ho Municipality (Järvelä 2012, 53-54).

The construction of the DT makes it suitable for most locations as the vaults are above the ground but one needs to consider the space that the storage of the waste requires. As the DT does not need water to function properly, it can be built in the areas where there is lack of water or funds to pay for the water, which both are common phenomena in Ho Municipality. (Järvelä 2012, 44-45, 56.)

According to Ms Järvelä (2012), the DT is one of the most inexpensive toilet facilities to construct and it can also bring economic benefits to the users if they use or sell the end products. The installation and material costs of urine diversion raises the total costs of construction but the costs still remain low as excavation work is not needed (Järvelä 2012, 47). Operation and maintenance costs are very low in private use as the maintenance of the facility as well as the emptying the vaults and urine tanks can be done by users, but in public use there are some operation and maintenance costs. Still, these remains lower than with other

common public toilet models in Ho Municipality, as they are connected to the septic tanks. The emptying of the tanks raises the maintenance costs remarkably. (Järvelä 2012, 48.)

The promotion of the DT concept could be done widely in the Ho Municipality as a consequence of the raised understanding of the dry toilet technology through the DT pilots in Ho (Järvelä 2013). The maintenance and emptying of the DT was identified to be one possible challenge as the human waste is considered smelly and harmful but the attitudes among the users are changing with the adequate education and familiarity with the facility and the end products. The sanitation habits and beliefs in Ho Municipality are not found to be a challenge of the promotion of the DT in the area. (Järvelä 2012, 59; Järvelä 2013.)

4 EVALUATION OF THE INSTITUTIONAL DRY TOILET

To evaluate the functioning of the institutional dry toilets, monitoring visits were organised to the DT pilot schools during June to August 2013. All schools were visited several times and during the visits, the condition of the facility, cleanliness of the toilets and the state of the compost were inspected. (Kettunen & Osmonen 2013a.) I carried out the initial monitoring with Northern coordinator Ms Anna Aalto, municipal SHEP coordinator Mrs Evelyn Vuvor-Nutakor and Environmental Engineer student Ms Piritta Kettunen. Further monitoring visits and other assisted activities were carried out during the student work placement with the assistance of the Ho Municipality's Environmental Health officers.

After the initial monitoring, a School Health Committee workshop was organised in June 2013 to tackle the observed challenges and more information from schools was gathered. The goals of the workshop were to find out solutions for the maintenance challenges and clarify the responsibilities and tasks of the School Health Committee members. (Kettunen & Osmonen 2013b.)

During the weekly monitoring visits in the schools, some of the challenges that the schools had had with the maintenance and use of the facility were solved. It was also decided to organize an exchange visit for the newer DT schools to the Regional Model School to have some practical training and user education on maintenance and use of the facility (Kettunen & Osmonen 2013b).

During the monitoring, some challenges in the maintenance and use of the dry toilet were observed but also some challenges in the technical solution were identified:

- Breakages of the urine tanks' pipes and valves,
- blockages in the urine pipes,
- water in the compost vaults,
- excess use of sawdust,
- girls' privacy questions,
- the unsuitable urinal on the girls' side,
- stirring and turning the compost and assessing its state,
- alternation of the vaults and squatting pans,

- lack of proper tools for turning the compost and opening the urine pipes,
- funding the maintenance and
- a slow response to the technical breakdowns. (Kettunen & Osmonen 2013a.)

As is widely known, all problems are a consequence of many different factors which can be divided to different categories. Table 1 below presents the main challenges in the dry toilet facilities. Further in the text below, I am going to survey the challenges in user-derived and technical aspects. In addition, so called administrative challenges, such as the inadequate support from Ho Municipal Assembly, have been a cause of many challenges.

Table 1. Observed challenges divided into categories

OBSERVED CHALLENGES	USER DERIVED	TECHNICAL	ADMINIS-TRATIVE
Breakages of the urine tanks' pipes and valves		X	
Blockages in the urine pipes	X	X	X
Water in the compost vaults		X	
Insufficient gathering of rain water		X	
Excess use of sawdust	X		
Girls' privacy questions	X		
The unsuitable urinal on the girls' side		X	
Stirring and turning the compost and assessing its state	X		X
Alternation of the vaults and squatting pans	X		X
Lack of proper tools for turning the compost and opening the urine pipes			X
Funding the maintenance			X
Slow response to the technical breakdowns			X

4.1 User-derived challenges

As a consequence of the insufficient knowledge of the dry toilet model, some challenges of maintenance and usage have been observed. Furthermore, the irregular and inadequate cleaning has affected the functioning of the dry toilet, and especially the urine collection system. In the school environment, the smaller pupils have experienced the squatting pan models confusing because of the two holes. The teachers and the pupils responsible for the facilities have found the assessing of the state of the compost and alternating the compost vaults and squatting pans challenging due to the lack of know-how. The education on the function and use of the facility as well as denser monitoring has been seen as a solution to these challenges.

The urine collection system has been one of the main challenges when considering not only the usability of the facility but also the usability of the end products. The sawdust added by the users, insufficient daily maintenance and misusing the squatting model have contributed to the blockages in the urine pipes. During the monitoring visits, it was observed that the daily maintenance actions, such as cleaning the facility and urine pipes, were not done as often as instructed or were neglected completely in certain schools even though it had been instructed to pay attention to the cleaning activities on a regular basis.

While cleaning the toilet room floors, extra attention should be paid to the sawdust or other dry matter not entering the urine pipes (Aalto etc. 2012, 20). New instructions were also given to add sawdust only twice a day by the maintainer and that the sawdust containers should be removed from the toilet rooms to prevent the sawdust entering the urine pipes (Kettunen & Osmonen 2013a).

The design of two different holes in the squatting pans has also been confusing for the youngest users and therefore they have defecated to the wrong section of the squatting pans causing blockages in the urine pipes (Kettunen & Osmonen 2013a). Regular education on the use and the maintenance of the dry toilet and practical training can prevent blockages in the urine pipes as users and maintainers understand the correct actions and their importance. Using a net on

the urine pipe holes has also been considered to prevent the sawdust entering the urine pipes, causing the blockages. During the monitoring visits and in the exchange visit it was demonstrated how to open the blocked pipes with a flexible stick. Schools pointed out that the stick could break into the pipes and there is a need for using a durable tool, such as a wire to open the blockages.

Assessing the state of the compost and maintaining it was widely experienced difficult, which is admittedly a consequence of the unfamiliarity with the compost. There were differences between the schools' activity in maintaining the compost, but it was generally noticed that the maintainers could not assess if the compost was either too dry or too moist. The maintainers did not have enough knowledge of the importance of stirring and turning the compost. This has led to an oversight of the maintenance of the compost and the faeces have been piling under the squatting pans and no mature compost has been producing. In addition to this, excess use of the sawdust added by users and hard copy paper used as cleansing material have been delaying the production of the compost as it has been too dry (Kettunen & Osmonen 2013a.)

It was also noticed that some unsuitable materials and objects ended into the compost vaults. This could be a consequence of the lack of trash-bins in the toilet rooms. (Kettunen & Osmonen 2013a.) By ensuring that there are trash-bins in every toilet room and with the regular monitoring of the state of the compost, the wrong use of the vaults can be prevented.

Alternating the compost vaults and squatting models has been confusing to some of the schools. The idea of the alternation system is easy to understand if it has been done in practice. As the dry toilets have been in use only for one year and a support have been offered by Ho Polytechnic in the pilot phase of the project, most of the schools have not had a need to alternate the vaults and squatting pans on their own. As a consequence of the inadequate maintenance of the compost, the faeces have piled under the squatting pans, which have made the pupils break the sealings of the squatting pans not in use (Kettunen & Osmonen 2013a). Due to these reasons, the alternation system was messed up. In some of the schools the alternation of the composting vaults and squatting pans were done during the monitoring visits (Kettunen & Osmonen 2013a). Also, marks were painted on the

composting vaults and above the squatting pans to ease the following alternations (Kettunen & Osmonen 2013a).

User-derived challenges are usually a consequence of the lack of adequate knowledge. Even though education on the use and maintenance of the facility has been arranged at the schools in connection with the opening of the dry toilet facility, using and maintaining the facility have been experienced as challenging. Unfortunately, the DT manual was not available at the time the dry toilet pilots were started and the schools did not have opportunity to learn about the DT technology enough to maintain the facility. In addition, the lack of support from the EHOs and the municipal SHEP coordinator has been delayed to embrace the dry toilet technology. During my work placement period in Ho, regular guidance was given to the schools to ensure that they get enough information on the DT and also the DT manuals and laminated instructions on the proper usage of the toilet were handed out. The importance of the support from the EHOs with the technical issues and the municipal SHEP coordinator with the education as well as the mutual communication between the schools and supportive actors was also emphasized.

4.2 Technical challenges

Technical challenges include breakdowns and design flaws. Some of the technical solutions of the dry toilet have not worked properly or the solution has not been appropriate for the purpose of the dry toilet. The challenges have appeared over time, which has contributed to breakages of the urine tank pipes and valves as well as rain water entering the vaults (Kettunen & Osmonen 2013a). Other challenges have been the blockages in the urine pipes and insufficient gathering of rain water, which can be classify to contribute from the technical solution. The urinal on the girls' side is constructed in the same way as the boys' urinal which is a design fault that should be corrected in future models. (Kettunen & Osmonen 2013a.) Plans for the repairs of the technical problems have been made but a few problems have been fixed temporarily.

The urine tank valves need to be working properly and easily while the facility is cleaned and the urine tanks are emptied. The installed valves have rusted and

broken as a consequence of the climate and weather together with the urine. The pupils have also used too much force when trying to open the rusted valves, which has caused breakages of the valves and breakages of the urine pipes too. With the assistance of Ho Polytechnic and a carpenter, the rusted valves have been replaced with stainless ones and the broken pipes repaired. The mechanism of the current valves (FIGURE 11) is also more durable in the local conditions than the previous one. (Kettunen & Osmonen 2013a.) As the carpenter did not have enough know-how on the urine collection system or the purpose of two alternating valves of the urine pipes, the repaired system does not allow diverting the cleaning water from the urine tanks.

FIGURE 11. On the left, the old rusted valve and on the right, the new more suitable valve

When the facilities were constructed, not enough attention was paid to the slope of the urine pipes. According to the Municipal Engineer Mr Dogbevia, the urine pipes are constructed with the slope but unfortunately it appears to not have been adequate enough to prevent the blockages in the urine pipes. When designing and constructing public or other institutional dry toilets the urine pipes need to be constructed with an adequate slope, as presented in the figure below.

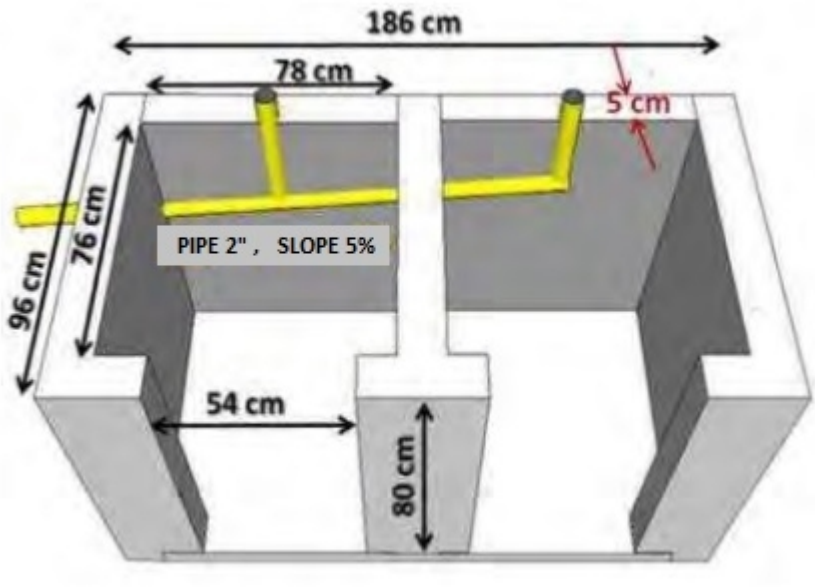

FIGURE 12. With 2" pipe, the slope of the urine pipes needs to be 5 %. (Rieck, von Münch & Hoffman 2012, 17 modified)

At some of the dry toilets, it was observed that rain water leaks to the composting vaults but a definite reason for that could not be determined. It was deduced that the most possible cause for the leakages was the joint between the ventilation pipes and the compost vaults' roof. As the composting vaults' roof is flat, rain water gathers on the roof and leaks into the vault. (Kettunen & Osmonen 2013a.) The roof should be leaning to prevent the water gathering on the roof. Also, the possibility of water raining in from the vaults' doors was considered since it was noticed that some of the doors were rotten (Aalto etc. 2012, 32).

The toilet facility should also offer urinals to both sexes in the school environment. Currently, there are urinals on both sides of the facility but the girls' urinal is unsuitable for female users. (Kettunen & Osmonen 2013a.) The dry toilet pilots are constructed with modified drawings of KVIP where there has not been a reservation for female urinals. The unsuitable model has been noticed during the piloting years and it has been decided that the room will be made into a changing room or storage room for cleaning equipment (Kettunen & Osmonen 2013a).

As the dry toilet technology has not been widely known, the challenges of technical solutions have been difficult to solve. The pilot project has offered extensive guidance and information to the local actors linked with the dry toilet facility and technology. The new technology has been introduced to the local

artisans during the two-days training organized by Municipal Engineers, Environmental Health Officers and Environmental Engineer students. The schools have also had more information through the practical trainings and the exchange visit. As there have not been established practices or standard models for requirements and use of dry toilet technology, the pilot project has been a learning process with good results and solutions.

4.3 Administrative challenges

Responsibilities for maintaining the facility and bearing the maintenance costs have been unclear to the schools and HMA during the piloting phase of the dry toilet even though the responsibilities have been informed to all parties. As has already been noticed, the lack of information and support for solving the problem situations are the main challenges when considering the function and the maintenance issues of the dry toilet pilots. According to the experience of the schools, the support from Ho Municipal Assembly has not been sufficient. It was also unclear who is in charge and who to inform in a problem situation as well as which actor is responsible for the minor and major challenges (Kettunen & Osmonen 2013a).

In the pilot phase of the DT project, there has been confusion over the responsibilities of the facility management. As the end products are used in the field trials, the schools cannot have taken total responsibility for the facility management. (Järvelä 2013.) During these first years of the project, the whole maintenance cycle and the facility management processes have not been clear or documented due to lack of experience. Once more information has been gathered and facility management plans can be made, the responsibility can be allocated in a clear way. After the pilot phase of the project, it is recommended that the facility management should be allocated to the party which will benefit of the end products. If the schools would like to use the end products or sell it to the farmers themselves, it is responsible for the maintenance of the facility and for the costs. However, it should be considered if there is need for private actors to handle the maintenance of the facility and the end products. (Järvelä 2013.)

As the DT fertilizers have been used in field trials and some cases in school fields during the pilot phase of the project, there has not been need for marketing these fertilizers. When the schools are taking the responsibility for the management and when the DT models are expanded, there needs to be a demand for the DT fertilizers to ensure the proper use and disposal of the end products. To ease the utilizing of the end products, the assembly and the Agricultural Extension officers are currently creating a demand for the DT fertilizers and organizing a controlled system to distribute the end products. (Järvelä 2013.)

In some of the schools, there have been uncertainties about emptying the urine tanks and compost vaults because of the lack of information. Even though the schools had contacted the Ho Municipal Assembly officers to inform that the urine tanks are full, the officers have not been able to offer decent assistance or further measures. To prevent the urine overflow, it was decided to change the emptying cycle to last only one term (Kettunen & Osmonen 2013a). After a three-month term, the schools have a one-month vacation. During the schools holidays the urine has time to sanitize and it can be used as a fertilizer after the school break.

There have been several challenges in the maintenance and use of the DTs, such as broken valves, blocked urine pipes, lack of proper tools for maintenance of the compost and insufficient gathering of rain water (Kettunen & Osmonen 2013a). The schools have not had adequate knowhow or financial means to solve the technical problems, which has complicated the fixing of the problems. In addition, it has been unclear who is responsible for maintaining the facility and managing the maintenance costs. These problems have been unsolved for a long period. To prevent further problems, it has been agreed that the assembly should be responsible for the major repairs and the schools for the minor repairs during the pilot phase of the project. This arrangement is, however, not the final solution and for the future facilities, a specific contract on the responsibilities needs to be made. (Järvelä 2013.)

The sustainable management of the facilities has been achieved due to active and enthusiastic individuals and SHC. Especially schools which have been utilizing the end products of the DT themselves have understood the concept of the DT and

the fertilising effect of the urine and the compost. In some of the schools, the DT has been utilized in the teaching as part of the science class education. The understanding of the DT concept and its benefits are the main aspects in realizing the importance of proper maintenance actions of the facility. (Järvelä 2013; Kettunen & Osmonen 2013a.)

During the pilot phase of the DT project, it has been noticed that good initiation will prevent the challenges of maintaining the facility and the maintenance costs. The responsibilities of every party should be clear already when planning to choose the DT facility to avoid disputes on the responsibilities. Therefore, it is important to make a clear facility management contract which includes all the vital maintenance actions and the responsibilities without any obscure allocations. In the pilot phase of the project, the schools have had assistance from the municipal assembly and other parties provided by the project. After the pilot phase, the total facility management is handed over to the schools and they can also benefit from the end products of the DT.

5 FEASIBILITY OF A PUBLIC DRY TOILET FOR THE HO CENTRAL MARKET

Even though the institutional dry toilet model is used as a baseline for designing the public dry toilet model, some technical modifications need to be considered. The public setting requires more technical and administrative capacity for safe and secure use and maintenance of the facility. The feasibility of the public dry toilet in Ho Central Market is studied based on the facility requirements in public settings, taking into a consideration the technical and maintenance challenges observed in existing institutional models in school environments, as well as examining other solutions for existing challenges.

5.1 Facility requirements

The Ho Central Market is a challenging area for any kind of sanitation solutions. The user convenience and capacity of the public dry toilet and privacy questions are the most important aspects when designing the public toilet facility to the area. Public settings create challenges and set limits to the technical and maintenance model. Also, recommendations for a public toilet facility at Ho need to taken into a consideration.

Community Water and Sanitation Agency (CWSA) has established guidelines for designing the sanitation facilities. There can be found a few criteria for public settings too and requirements for appropriate hygiene and sanitation promotion. According to CWSA (2010), all latrines shall be designed and constructed according to the following:

- Hand washing facilities
- Free from flies and odours
- Safe disposal of human excreta
- Providing adequate privacy
- Stable structure
- Considering the physically challenged

Furthermore defining criteria for basic designing of the facilities are the sludge accumulation rate and the number of users per toilet pit. To calculate the required

capacity of the facilities, 0.06 m^3 per person per year for dry latrines can be used as the sludge accumulation rate and 50 persons for institutional use as a population per toilet pit. (CWSA 2010, 8-9.) It needs to be noticed that the sludge accumulation rate also includes the urine, which causes the higher amount of toilet waste per person than the generally used amount only for faeces. With the definition of the number of the users per toilet pit and the number of estimated users, it can be calculated that the public dry toilet should include five toilet rooms for both sexes.

The public dry toilet facility requires adequate capacity for urine and faeces collection as well as a sufficient number of toilet rooms. The capacity can be estimated from the amount of urine and faeces from public dry toilet with the commonly used volume of excrements per person per year and with the estimation of usage of the facility. It is estimated that the number of public toilet facility users increases due to the growth rate of the Ho Town and the renovations planned to Ho Central Market from 400 users to 500 users per day. If an average amount of urine excrement of one person is 300-550 litres per year (Richert, Gensch, Jönsson, Stenström, & Dagerskog. 2010. 17), 500 users excrete 410-750 litres per day, which can further be divided to the amount of one toilet visit. The average amount of faeces of one person is 50 litres per year (Aalto etc. 2012, 34), which results in 70 litres of faeces from 500 users per day. These calculations will be taken into consideration when the feasibility of composting on site and the urine collection system is studied.

5.2 Identified challenges and solutions

During the piloting years, there have been some technical and operational challenges of the institutional dry toilet model, which must be solved when modifying the institutional dry toilet model for public use. Also, some issues related to the technical solution and maintenance model of the public dry toilet facility have been considered with the Ho Municipal Assembly, especially with the Environmental Health Officers and Municipal Planning Officers.

The main challenge concerning the DT in public use is the on site treatment of human excrements. Composting the faeces on-site have been observed to be

challenging to maintain in school environments and therefore it can be assumed that the maintenance of the composting in public settings will also be demanding as a consequence of the higher amount of faeces. Composting off site has been seen as a solution to ensure the safe composting of the faeces, but the land for composting off site is not currently available (Dogbevia 2013; Fugar 2013).

The urine collection system has had several challenges when considering its technical solution. Blockages and breakages in the urine pipes and rusted valves have been the main concern of urine collection but also the unsuitable urinal for female users affects the usability of the dry toilet facility. Some repairs have already been done in the existing institutional models but the main challenges can be solved only by designing and constructing the urine collection system to function properly.

With the correct design of the superstructure of the facility, including the number of toilet rooms and a technical solution for a toilet seats or squatters, the user convenience can be ensured. Also, the adequate user training guarantees the proper use of the facility in public settings.

As there is a need for modifying the technical design of the institutional dry toilet model for public use, there is also a need to update the recommendations of the maintenance activities. While studying the technical solutions, the maintenance of the facility should be renewed and new instructions listed to ease the understanding of the needs of the facility maintenance.

5.2.1 Feasibility of on-site composting

On-site composting in Ho Central Market has been seen as a challenging alternative according to Municipal Engineer Mr Dogbevia, Municipal Planning Officer Mr Fugar and Environmental Health Assistant Ms Zottor interviewed in 2013. Even though the composting process would not take 12 months in the conditions of Ho, the extermination of the pathogens in the faeces must be ensured with adequate time. The recommended one-year composting time is too long a period to keep half of the facility’s capacity closed in public use.

As the double-vault on-site composting system is not possible in public use, off-site composting should take place. There has been the same issue in other urine diverting dehydration toilets (UDDT) in institutional use but the case of Valley View University (VVU) in Accra, Ghana, provides guidelines with the same cultural aspects and climate conditions. One of the bases of the VVU's UDDT has been composting off-site (Okan-Adjetey 2013, 2). The faeces are collected to a moveable container where the pre-composted faeces can be transferred to the final composting site (Okan-Adjetey 2013, 3-4). Figure 13, presents the principals of the collection system of the faeces. This possibility will also be possible in the public dry toilet in Ho Central Market if the compost plant in Ho is constructed as planned. It can be assumed that to improve the composting process the compost plant will need a nutrient rich material that the faeces from public dry toilet provide.

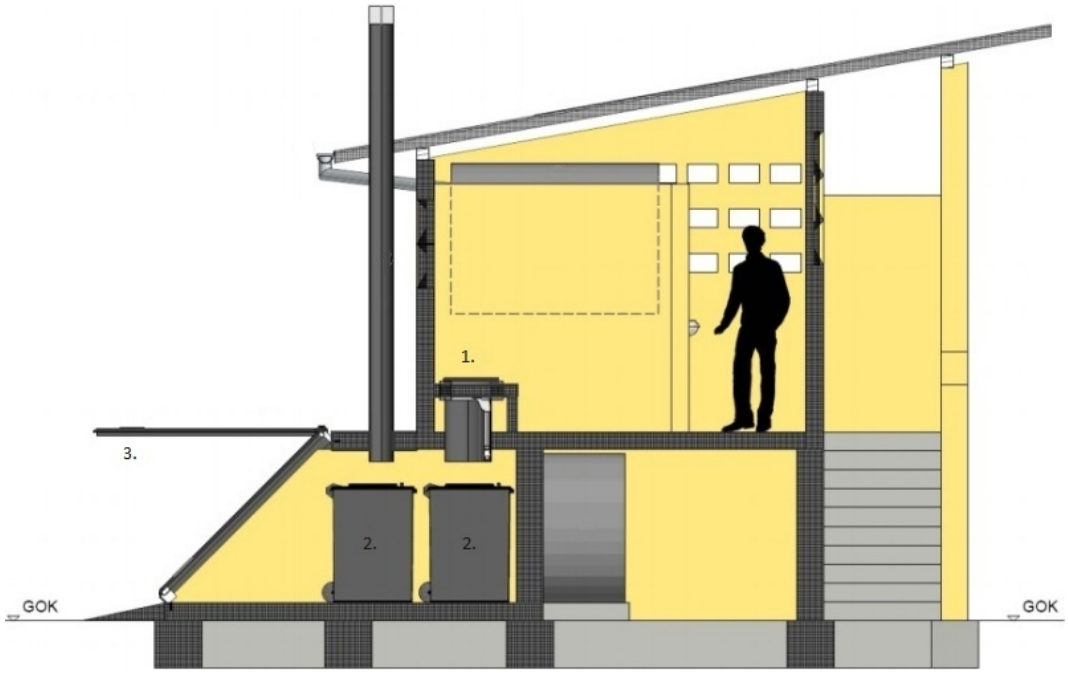

FIGURE 13. UDDT at VVU. 1. Urine diverting toilet. 2. Exchangeable mobile containers. 3. Door for exchanging and emptying the containers. (Berger Biotechnik GmbH, 2013 modified)

As can be seen in Figure 14, the VVU has used the 240-litre trash bins with wheels as moveable containers for collecting the faeces. A sufficient number of toilet pits being 10, there is also a need for 10 containers for faeces. With 10 containers the capacity of the facility will be 2400 litres, which will fill up in 34 days in public use (Table 2). This results in an emptying period of one month,

which has been currently used in the public toilets in Ho Central Market. If there is a need to extend the emptying cycle, for example to two months, the number of the containers should be doubled.

FIGURE 14. Moveable containers for gathering the faeces (Okan-Adjetey 2013, 3 modified).

Table 2. Required emptying period of the moveable containers with the volume of 240 litres

Number of the moveable containers	Capacity of the facility for faeces (l)	Emptying cycle
10	2400	1 month
20	4800	2 months

If the faeces are collected to the moveable containers and the emptying cycle is as short as presented and, furthermore, if the faeces are treated off site in the compost plant, the maintenance of the facility will become easier. However, the off-site composting needs a transportation of the faeces. The transportation of faeces can be organized with a vehicle designed for the moveable containers. If the vehicle is too expensive to implement only for the toilet facility, the opportunity for a larger scale collection system of the organic waste in the Ho Central Market area could be studied more. Also, the service provider for emptying and transportation needs to be surveyed further.

As it is not possible or even expedient to produce mature compost on site in public settings, the solution of off-site composting with the moveable containers

will provide the hygienic gathering and transfer of the faeces and, more importantly, the safe treatment of the faeces.

5.2.2 Feasibility of on-site treatment of the urine

The urine should be sanitized for one month, especially if the urine is collected from a public toilet, to ensure the hygienic use of the urine as a fertilizer. As a consequence of the one-month storing time of urine it needs to be resolved if the on-site treatment of the urine is practicable in the public dry toilet in Ho Central Market. In addition, it needs to be resolved if the structure of two urine tanks with the capacity 1400 litre,s as currently constructed in institutional dry toilets, could be suitable for public use.

As mentioned before, an average amount of urine excrement of one person is 300-550 litres per year. As it is widely known, the amount of urine depends on the amount of water consumed and on the climate conditions and therefore the amount of urine could be lower. Taking into consideration the climate conditions in Ghana, it can be assumed that people need to urinate at least two times per day but usually more. When calculating the capacity and emptying period of urine tanks, the average amount of urine per one user (Table 3) is used. If the number of users in the public dry toilet is 500 per day and an average amount of urine is 0.27 litres per user, the production of urine will be 135 litres per day, which means 4055 litres per month (Table 4).

Table 3. Calculation for an average amount of urine

Number of toilet use per day per person	Amount of urine per toilet use
2	0.42
3	0.28
4	0.21
5	0.17
3.5	0.27

Table 4. Production of urine from 500 users per day

Time	Amount of urine in public dry toilet (500 users/day)
1 day	135 litres
1 week	946 litres
1 month	4055 litres
1 year	48 666 litres

If the same urine tanks are used with the same capacity that are used in existing institutional dry toilets, the facility would require three urine tanks to gather the monthly amount of urine. If it is wanted to treat the urine on site and create an alternation system, the number of urine tanks should be doubled. If the number of urine tanks for on-site treatment is not possible to implement in Ho Central Market as a consequence of a limited size of the land for all reconstruction plans and resources, needs for the off-site treatment should be determined.

Off-site treatment could ensure the required time for storing the urine. In the institutional dry toilet, there is a place for two urine tanks with the capacity of 1400 litres, which can also be used in public model. The amount of the urine being 135 litres per day and with two urine tanks, the urine tanks need to be emptied in every 20th day and stored in another location for one month (Table 5).

Table 5. Emptying periods for urine tanks

Number of the urine tanks	Capacity of the urine tanks (l)	Emptying period (days)
2	2800	20
3	4200	31
4	5600	41
6	8400	62

By adding more urine tanks, the need for emptying of the urine tanks will decrease and it could also be considered if it is possible to create two different urine collection systems: one to gather the urine from the urinals and the other one to gather the urine from the toilet rooms. This would also ensure the collection of clean urine, without any impurity from toilet room floors or solid toilet waste even though the urine collection system from toilet rooms is out of order.

As the institutional DT has been designed to treat the excrements on-site, the storing of urine for one month would have been the optimal solution. Due to the high amount of urine, the limited space for the ancillary facilities in the Ho Central Market area and in addition, the high price of the construction of on-site treatment of urine, the option of off-site treatment should be considered. The off-site treatment of the urine requires emptying of the urine tanks and currently a potential option for that is the emptying of the urine tanks to the other containers. The optimal solution for transportation of the urine tanks would be moveable urine tanks which also enable the storing of the urine for a month. This arrangement requires a doubled number of urine tanks and also alternation system of urine tanks.

5.2.3 Feasibility of female urinals

The public toilet facility should also offer the opportunity to use only the urinal if the customer needs to. In addition, the Ho Municipal Assembly has planned to construct 20 urinals at markets and lorry parks (HMA 2012, 38). The institutional DT is designed with one urinal for both sexes beside the toilet rooms but the urinal on the female side has not been suitable for female users, and therefore another model has to be considered for female urinals in the public DT model. One of the facility requirements also define that all latrines need to be designed in a manner that is easy to use (CWSA 2010, 9).

In Ghana, the “drain urinals” are generally used for female users, which are commonly used also in the public toilet facilities in Ho Central Market (FIGURE 15). The drain urinal model would be easy to use and already familiar to local customers. To ensure the value of the urine as a fertilizer, it needs to concentrate on the urine collection system and the nutrient content of the urine. If the urine is

led to a closed urine collection system with the adequate slope of the drain, the nutrient stagnation would remain low. Thus, the drain urinal could be seen as a solution of the urinal model for female users.

FIGURE 15. "Drain urinal" for female users in Ho Central Market

5.2.4 Evaluation between the squatting and seated model

In Ho Municipality, the squatting model and the seated model can be found in the household latrines as well as the public toilet facilities. Both models can also be constructed as dry toilets, but due to the circumstances of the public use, some practical issues need to be considered. Also, reconstruction of Ho Central Market sets expectations for a public DT.

Usually the seated model is used in household latrines when only family members are using the latrine and cleaning is simple to organise. In public use, the hygienic issues are the most important aspect when designing a toilet facility. As the seated model has been considered unhygienic in public or institutional use, the DT model in schools has been constructed with the squatting model instead of the seated model. The squatting model has also been seen as more convenient to clean in the school environment where the pupils are responsible for the daily cleaning

activities. Even though the public toilets have their own cleaners and maintainers, the squatting model is easier to clean as the facility is often used and cleaning needs to be done several times per day. The squatting model is also widely used in toilet latrines in Ho Municipality as well as in Ghana generally and the local people do not shun the model. Also, in the public toilet facilities in Ho Central Market, the squatting model is the main option in public use.

As Ho Central Market is planned to be reconstructed to an ultra-modern market area with needed ancillary facilities, the seated model could represent the same high profile in a public DT. Also, it could be seen that the seated model is a more user friendly option especially for the elderly and people with disabilities. Toilets in public use should be cleaned several times a day and with its own cleaner or maintainer the seated model will be as hygienic as other models.

Even though the squatting model has been the most suitable model for the institutional use in schools, it must be considered if the seated model offers easier and more comfortable option for all the users in public settings in Ho Central Market. In addition, the expectations for the reconstructed market area are high and the sanitation facilities should represent the high profile of the central market area of Ho municipality.

5.2.5 User guidance

There have been some uncertainties in using the DT facility in the pilot schools. The main challenge considering the use of the facility has been the design of the squatting pan. As the design of the squatting pan consists of two separated holes for excrements, the use of the squatting pan has been confusing for the youngest users. The misusing of the squatting pans has caused blockages in the urine pipes, which needs to be avoided in a public DT facility. The information of the DT concept as well as the know-how of using the DT facility should be brought to the awareness of users.

The user education has been carried out in DT pilot schools by the School-based SHEP Coordinator and pupils with the assistance of the Municipal SHEP Coordinator and the Environmental Health Officers. As the maintenance of the

DT is the responsibility of users, the maintenance education has been one of the main topics during the sanitation education. This has had a significant impact on the functioning of the DT. If the maintenance of the public DT will be a responsibility of private employees, there would only be a need to organise an education of using the facility.

According to the CWSA (2010), appropriate hygiene and sanitation advertising needs to be carried out in all communities, which encourages organizing education events on a regular basis to introduce the public DT facility in Ho Central Market. At a same time the DT concept could be promoted. In addition to the education events, the know-how of using the facility could be presented with laminated instructions. The instructions are installed on the facility entrance in the pilot schools, even though there have been recommendations to install the instructions in every toilet room. In the public DT, there is a need to install the instructions in every room to ensure the proper use of the facility.

As the public toilet facilities at Ho are generally constructed with the squatting model, except WC latrines, the use of the model should not be unfamiliar. Only the design of two different size holes could cause uncertainties in using the latrine, but the instructions with pictures will help the users. Uneducated users are not the main challenge in public settings, because it is not important to understand the function of a DT while using the facility. However, it is vital to let the customer know how the facility should be used.

5.3 Evaluation of administrative models

As generally in Ghana's urban areas, the operation and management of public sanitation facilities is extremely challenging also in Ho Central Market. In Ho Central Market, there are currently two different administrative models to operate and manage the public sanitation facilities, but unfortunately the management has been inadequate with both models, consequently causing environmental and health risks to the surrounding areas. Therefore, it needs to be resolved if the operation and maintenance of the public DT facility could be improved.

The management of public toilet facilities in Ho Central Market are delegated partly to the HMA and partly to the private actor. Two STLs are managed by HMA, which accrues a percentage of their revenues from user fees as well as from the WC facility operated by a private actor. As has been noticed before, the maintenance of these toilet facilities has been challenging and according to MLGRD (2012), the management and maintenance of public toilets shall be transferred to the private sector and the metropolitan, municipal and District Assemblies are responsible for monitoring, regulation and facilitation roles.

As the public DT should be designed to serve 500 users per day, consisting of 10 seats and with off-site treatment of urine and faeces, the management and operation need to be ensured to work properly. In Kumasi, located in southern part of central Ghana, the existing management models have been noticed to work poorly and WSUP is supporting the Oforikrom Water and Sanitation (OWAS) project to deliver clean water, enable the access to improved sanitation and improved hygiene behaviours (WSUP 2012, 2). As a part of the project, a new service model for a public toilet facility has been demonstrated, this involves the community, represented by a Community Management Committee (CMC), Ghana Urban Water Limited (GUWL) and the KMA to a partnership (WSUP 2012, 3). This approach could also be developed in Ho when considering new public toilet facilities in Ho Central Market.

5.3.1 Management model of the public toilet facility developed in Kumasi

As the KMA has an original intention of franchising the sanitation block through a public tender, the CMC was formed to fit a central role for operation and maintenance (WSUP 2012, 11). To develop a suitable management model, also a Project Steering Committee (PSC) was formed. PSC became a forum for initial discussions including implementation issues and share challenges. CMC presents a suitable community-based entity. With these parties, it was possible to organise discussions and negotiations between all stakeholders, traditional leaders, the community, the representatives of GWCL and KMA. (WSUP 2012, 9.)

As the management arrangements required a partnership between the community and the service provider, GWCL, the CMC was formed early. The CMC should

be closely tied to the formal local government structure rather than creating new parallel structures, and therefore it is constituted as a legal entity under the Oforikrom Sub-Metropolitan Council, which is one of the Sub-Metropolitan Districts. (WSUP 2012, 9.) The KMA has delegated many of the functions to the Sub-Metropolitan Districts including waste management, sanitation and environmental health (WSUP 2012, 3). The constitution and membership of the CMC is nominated by traditional leaders, opinion leaders, women's groups, the youth club and the District Assembly representative for the area, and also include membership of the KMA, the Oforikrom Sub-Metropolitan Council and GWCL (WSUP 2012, 9).

With the support of a programme of formal and practical capacity building activities, including training on the roles and responsibilities of all parties under the new management arrangements, such as record keeping, managing and reporting performance, budgeting and tariff setting, it was ensured that after initial support to the CMC, it is possible to work within a costing system that will be financially viable. (WSUP 2012, 9.)

A contractual arrangement has been made between the Oforikrom Sub-Metro Council and the CMC to define the responsibilities of the operation and management of the facility (FIGURE 16). CMC is responsible for the operation and management of the facility including maintenance, cleaning and emptying of the facility, collection of user fees as well as employment of necessary personnel. (WSUP 2012, 12.)

FIGURE 16. Contractual arrangements for management of communal toilet block (WSUP 2012, 12).

The KMA is the legal owner of the facility and responsible of regulation and approval of user fees, and it also take care of the oversight function, the CMC shares the profits generated for a time-limited period, initially two years (FIGURE 17). To ensure the financial sustainability of the services, the CMC is obliged to

use the surplus for other water and sanitation projects of the community. (WSUP 2012, 12.)

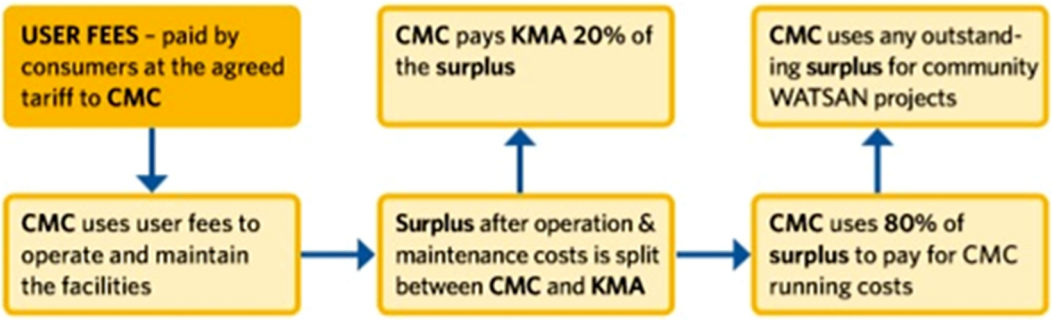

FIGURE 17. Summary financial flows (WSUP 2012, 12)

5.3.2 Feasibility of the management model for a public dry toilet facility in Ho Central Market

In June 2013, a workshop was organized on sanitation in Ho for the EHOs of HMA. One of the main topics was a public DT facility and how it could be operated in public settings. As a result, some main baselines and ideas for the administrative model of the public DT were suggested. (Aalto 2013.) Taking into consideration that the currently existing management models are not working properly in Ho Central Market, new ideas for operating and maintaining the facilities could be developed. Moreover, it needs to be ensured that the management model of the public DT is suitable for the settings and habits of Ho Municipality.

The Sanitation workshop resulted in a recommendation which proposes that the HMA invests in a facility of its own (Aalto 2013). The same model is also used in the new management model in Kumasi but the MLGRD's (2012) recommendations to transfer the management and maintenance of public toilets to the private sector need to be considered. This results in the combination that the HMA would be the legal owner of the public DT facility and the management and maintenance would be a responsibility of another party.

As it has been learnt during the pilot phase of the DT project, it is vital to involve different parties tightly to the management of the facility. In the school

environment, the SHC has had the main responsibility for the successful operation of the facility management. Due to lack of adequate resources of HMA to respond to the maintenance challenges observed in schools and public toilets in Ho Central Market, the new management model from Kumasi could be modified to suit the conditions of Ho.

In Kumasi, the CMC has included members from all the parties that are involved with the sanitation facility from the community, service providers and higher authorities like the KMA, to manage and maintain the sanitation facilities (WSUP 2012, 9). To ease the clear division of the responsibilities of the management of public toilets in Ho Central Market, a committee for managing and maintaining the facilities could be formed under the HMA. It needs to be ensured that the committee includes members from all the important parties from service providers and the HMA to vendors and users of the market area.

To ensure proper and adequate management of the public DT, a delegated management system between HMA and the committee formed under the HMA needs to be introduced (FIGURE 18). Even though the HMA will be the legal owner of the facility, it represents only a facilitating and monitoring role. The committee formed for sanitation facilities of Ho Central Market will be responsible for services and operation of the facility, including maintenance, cleaning and emptying activities and collection of the user fees as well as employment of necessary personnel. After the maintenance and operation costs, the committee is required to share the surplus from user fees with HMA.

FIGURE 18. Organising management of a public dry toilet facility at Ho

As has been noticed before, clear and specific contracts need to be made between HMA and the committee as well as between the committee and employees or private carpenters, plumbers and emptiers needed. This will clarify the responsibilities of all parties involved in the management of the facility.

6 CONCLUSIONS AND RECOMMENDATIONS

The aim of the study was to examine the suitability of the currently used DT model with double-vaults in Ho for public use. The technical solution and maintenance model of the institutional DT have been designed for a school environment and they are not adaptable as such to be used in public settings. During the pilot phase of the DT project, some technical challenges and lack of management and maintenance of the DT have been detected. These challenges have been taken into consideration when studying the suitability of the institutional DT in public use. Also the requirements and recommendations of public toilet facilities at Ho have been noticed. Due to the lessons learned, some modifications and adjustments need to be made to make the DT model suitable for public use.

The main challenges, considering the suitability of institutional DT in public settings in Ho Central Market have been the technical design and maintenance of composting and treatment of the urine on site. As a consequence of the high amount of urine and faeces and the required treatment times, the on-site composting and treatment of the urine have been seen as an unsuitable model for public use in the market area.

Plans of the GUMMP enable a possibility of construction of an off-site composting system. Recommended off-site composting requires some modifications to the institutional DT model. The collection of faeces needs moveable containers which can be emptied with a garbage truck designed for this use. The emptying cycle with 10 containers and with the capacity of 2400 litres will be once per month. To extend the emptying cycle, the number of containers could be doubled. As the GUMMP includes plans for a composting plant, the faeces could be transported to the plant. This arrangement provides valuable material for the composting process in the composting plant and creates the opportunity to extend the collection of organic waste to cover the whole Ho Central Market area. A large-scale collection of organic waste from the Ho Central Market area provides a reasonable possibility to invest in a vehicle to collect and transport the waste to the compost plant.

The on-site treatment of the urine requires more resources than can be expected from a public dry toilet facility. As the public dry toilet can be constructed with the possibility of off-site treatment of the urine, this approach is recommended. There are two different options to implement the off-site treatment of the urine. The first option is the construction of two urine tanks on both sides of the facility. When the urine from toilet rooms and urinals is collected to two urine tanks, the emptying period will be 20 days. The second option is the construction of three urine tanks on both sides and in the middle of the facility. This option requires modifications for the technical design of the facility. The urine from the toilet rooms is collected to the urine tanks on both sides of the facility and the urine from the urinals, placed in the middle part of the facility, is collected to its own urine tank under the urinals. Thus, the emptying period rises to 30 days and this also ensures the collection of urine without impurities from faeces. From the urine tanks, the urine needs to be emptied to smaller containers and transported to the off-site treatment.

To provide urinals for the both sexes, the currently existing urinal for female users needs to be changed to a suitable model. As the drain urinals has been easy to use and a widely used model in Ho, it can also be adapted to the public DT. To secure the nutrient content of the urine, the drain needs to be constructed with an adequate slope. As a consequence of reconstruction plans of Ho Central Market, the seated model for toilet rooms has been seen a more suitable option than the squatting pan. The seated model also provides user convenience for the elderly and people with disabilities and is easy to use.

The facility management, including maintenance and cleaning of the facility, emptying of the urine tanks and compost vaults, collection of the user fees and operating the facility, requires special attention in public settings. As the Ghana National Environmental Sanitation Policy has directed, the operation of public sanitation facilities should be delegated to the private sector and Municipal Assemblies should have only facilitating and monitoring roles. The administrative mode of a public DT needs to be organized as the national targets present. It also needs to be taken into consideration that currently existing management models of public toilet facilities in Ho Central Market are not organized sustainably, due to inadequate resources.

A sustainable management model for a public DT facility requires involvement of all the parties that are seen important in sharing responsibilities of the management and operation issues. As the HMA represents only a facilitating and monitoring role, another organisation needs to be considered to take the responsibility of the management of the facility. To enable sufficient information flow and communication channel between HMA and all the other parties, the possibility of forming a committee for the maintenance and operation of the public DT needs to be studied more.

To summarise, the following modifications are recommended, to create a sustainable DT model in public use:

- Creating off-site treatment for urine and faeces
- Female urinal needs to be modified to suit female users as drain urinal
- Seated model in toilet rooms is more appropriate for public use
- Creating a sustainable and involving administrative model to manage the maintenance and operation of a public dry toilet

Even though the modifications in the technical design and a administrative model were feasible, more information is needed and more research needs to be done. If the composting off-site could be implemented through the GUMPP's plans of a composting plant, organising of the transportation and a larger scale collection system of organic waste from the Ho Central Market area need to be studied further. Before the urine collection system could be designed properly, the decisions of the implementation options need to be made. The off-site urine treatment requires emptying of the urine tanks to other containers. It could also be resolved if more moveable urine containers can be implemented and an alternation system created for the urine collection. Thus the urine can be stored in the tank without emptying. The modifications of the technical design require new drawings and the urine pipes need to be included in the details. All decisions depend on the implementation and management costs, which need to be taken into consideration. Furthermore, the new approach of the administrative model should be studied further to determinate which parties should be involved in the management and maintenance of the public DT.

Before the public DT is ensured to be sustainable toilet facility model in Ho Central Market, the following issues need to be studied more:

- GUMPP's plans for a composting plant and the possibility of cooperation between the Ho Central Market area and the engineered landfill
- Easier option for transportation of urine
- Proper drawings of the selected DT model
- Implementation and management costs
- Parties required for the administrative model.

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APPENDICES

APPENDIX 1. Interview on the possibility of a public dry toilet at Ho Central Market

Name:

Status:

Date:

Public toilets at Ho (capacity, service net?)

- Adequate?
- Expanding? (how much, where?)

Ownership of the current public toilets (assembly/private)

- Assembly: How it works? Benefits? Maintenance?
- Private: How it works? Benefits? Maintenance?
- Which is better model (for a public DT)?

Current challenges of the public toilets in Ho?

- Solving the challenges?
- What are the main issues on solving the challenges?

Dry toilet model for a public toilet in Ho Central Market

- What do you think about the idea of a public DT at Ho Central Market?
- How the operational and maintenance of the public DT should be organized?
    - Ownership?
    - Which parties should be involved?
- How many toilet rooms should the public toilet facility include?
    - Capacity?
    - Number of users?
    - Urinals?
- Are the on-site composting and treatment of urine suitable for public use?

APPENDIX 2. Interview on the current public toilet facilities at Ho Central Market

Name:

Status:

Date:

Basic information

Building year:
Toilet type:
Number of employees (names if interviewed):
Opening hours:
Number of users/customers:
Hand washing availability:
Toilet paper availability:

Technical information

Is the capacity of the toilet adequate?

- Emptying cycle?
- Who is responsible for emptying and how it is organised?

What are the main challenges?

- Main challenges of the technical design?

How much did the toilet facility cost? (building, builders)

Operational information

How the maintenance of the facility is funded?

- What kind of maintenance costs this facility requires? (toilet paper, water)
- What are the main costs in this facility?

How much does the customer pay for the facility?

- Incomes or only for maintenance?

Number of employees?

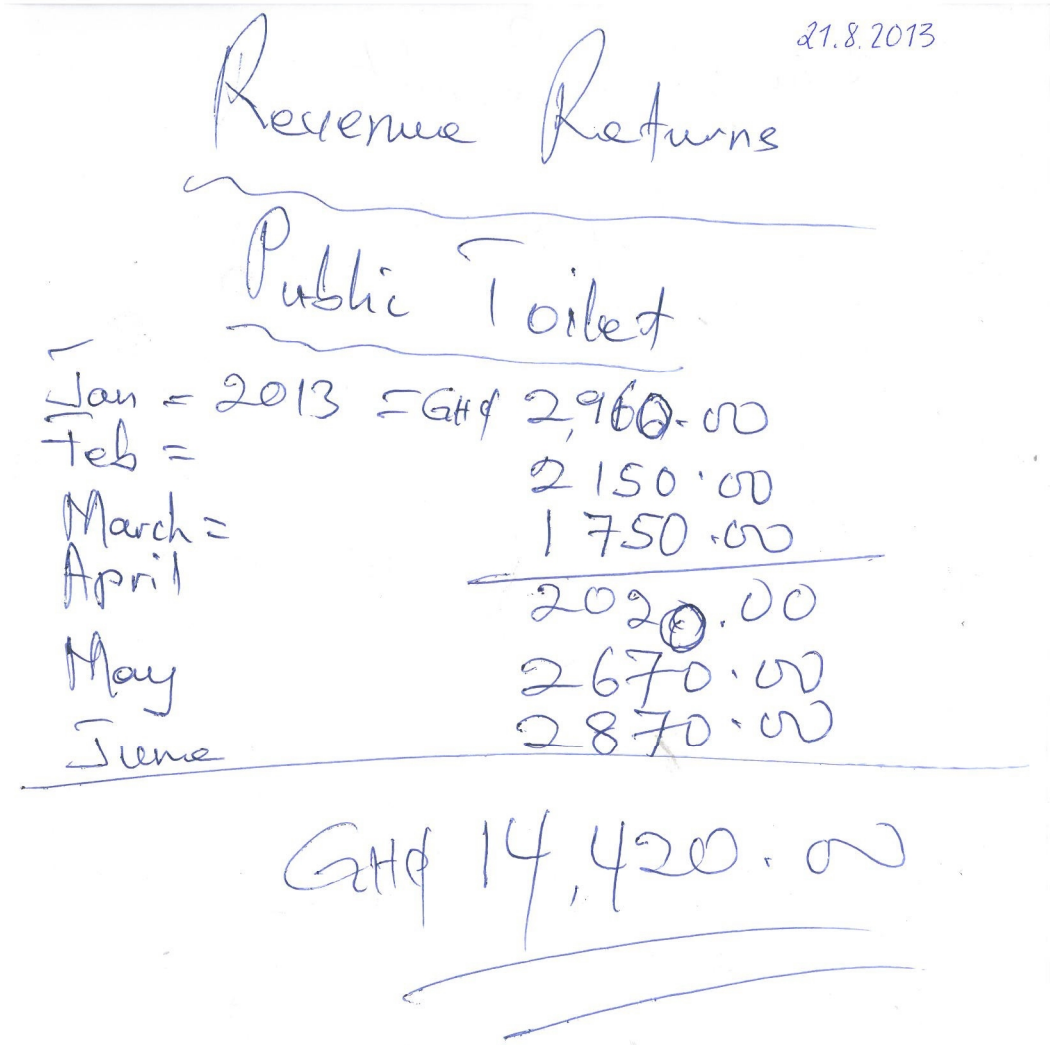
- What are the main tasks and responsibilities?
- Salary?

APPENDIX 3. Photo collage of the first Septic Tank Latrine in Ho Central Market

APPENDIX 4. Photo collage of the second Septic Tank Latrine in Ho Central Market

APPENDIX 5. Photo collage of the Water Closet Latrine in Ho Central Market

APPENDIX 6. Revenues of two public toilet facilities at Ho in six months period



21.8.2013

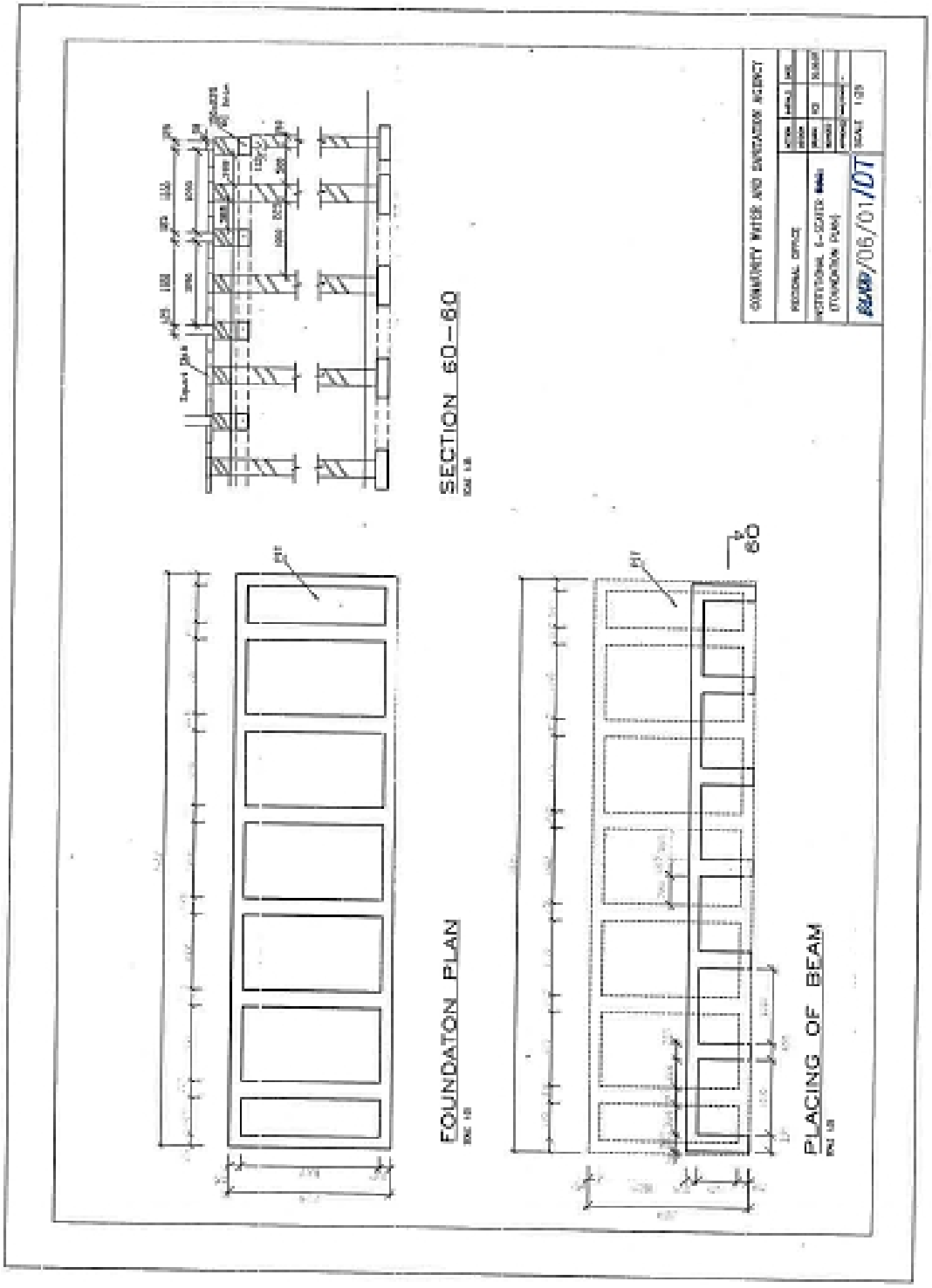
Revenue Returns

Public Toilet

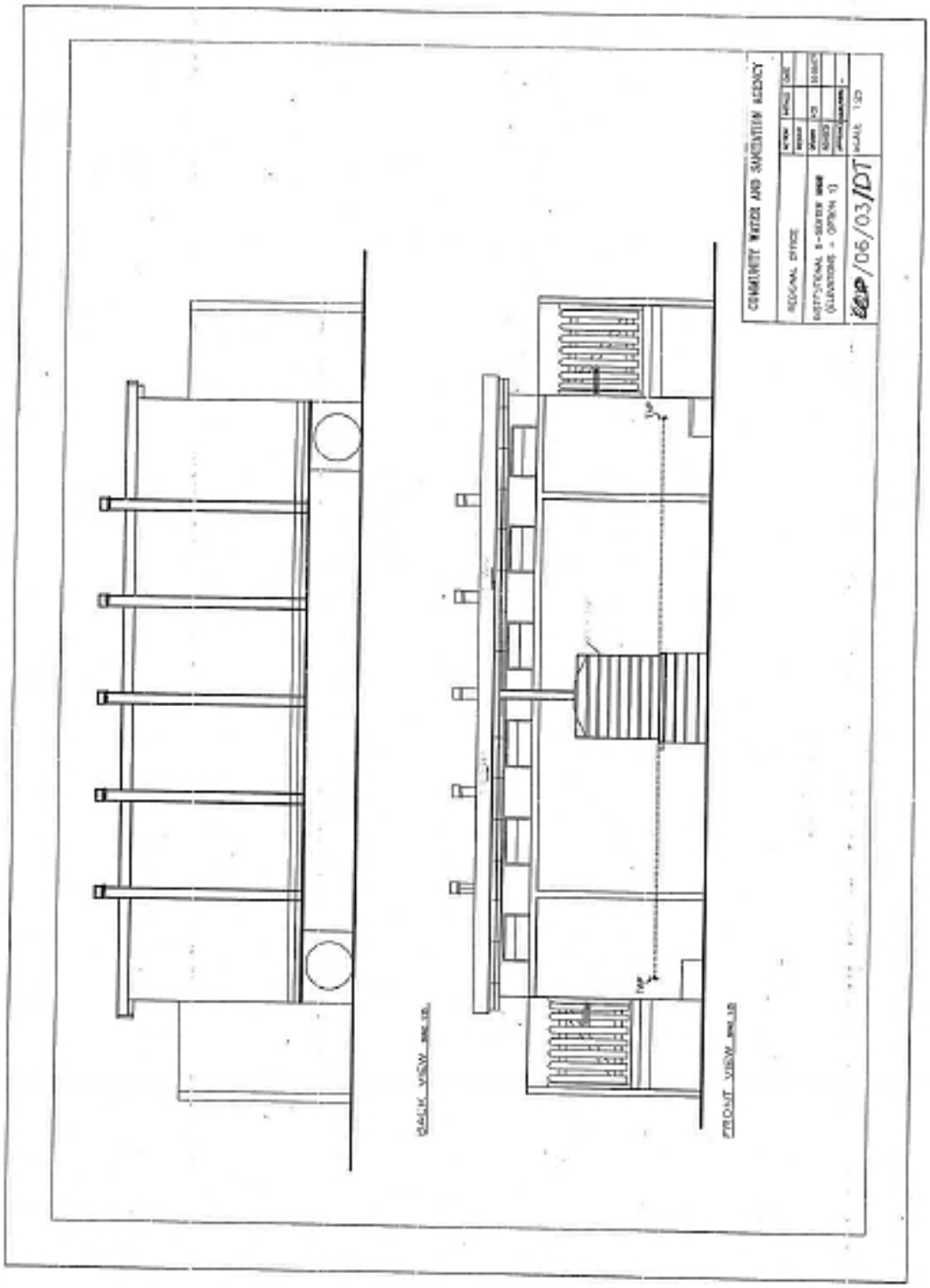
Jan = 2013 = GH¢ 2,960.00
Feb = 2150.00
March = 1750.00
April 2020.00
May 2670.00
June 2870.00

GH¢ 14,420.00

APPENDIX 7. Page 1 Drawings of the institutional dry toilet, 6-seater



APPENDIX 7. Page 2 Drawings of the institutional dry toilet



APPENDIX 7. Page 3 Drawings of the institutional dry toilet