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From Waste to Wealth: Overcoming the Barriers to Sanitation Development with Co-Design of Low-Cost Urine-Diversion Dry Toilet Technology

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DRY TOILET 2015

5th International Dry Toilet Conference

Abstract

Current statistics reveal that Ghana is significantly lacking behind on Millennium Development Goal targets with less than 10 per cent of rural population having access to improved sanitation. In Ghana, the adoption rate of household toilets is relatively low compared to other countries of similar economic status. This is especially due to the common practise of shared toilets. Furthermore, other contributing factors include households' lack of investment capital and absence of strong socio-cultural norm that would encourage toilet ownership.

The lack of sanitation facilities is equally pertinent in Ho Municipality, Volta Region, where open-defecation is a wide-spread practise especially in the rural areas. In Ho, the previously advocated sanitation facilities for rural areas are Kumasi Improved Ventilated Pit toilets (KVIP), Mozambique lined, Mozambique unlined, Samplat and Rectangular pit latrines. The cultural acceptability of these pit latrine technologies is low due to the offensive odours and hot vapour that are associated with spreading of diseases. Moreover, stony ground and water-logging have hindered toilet construction in many areas.

North-South Local Government Co-operation of City of Lahti in Finland and Ho Municipal Assembly in Ghana has identified ecological sanitation development as a key area for co-operation. Since 2009, Urine Diversion Dry Toilet (UDDT) technology has been introduced to Ho Municipality through a technical pilot at local schools in order to determine technical, economic and socio-cultural sustainability before larger-scale implementation. Based on various studies, potential of UDDT technology for Ho was deemed very promising and extension to households was initiated.

The household UDDT pilot was started in June 2014 as the first pilot model was built to a community of Akrofu Xewiwofe. The building process involved local artisans who were trained on the technology in the course of the construction process. Simultaneously, the interest for ecological sanitation has grown significantly as a result of the extensive field demonstrations with urine fertiliser and related radio outreach program. There is a definite growing public interest for acquiring a UDDT facility, especially among farming communities. However, the price of the facility has been forming a barrier for widespread implementation.

In the course of the pilot construction, specialists and students from Lahti University of Applied Sciences, engineers from Ho Municipality's Works department and the local artisans have been involved in a co-designing effort to adjust the cost-structure of the original design. Fluctuating material prices, distance and locals' unfamiliarity with the household-oriented UDDT technology have formed challenges to the design process and the intention is to continue the co-designing process in the coming years as the expertise is accumulated. However, even in the first re-design piloted in December 2014, the price of the facility has already been halved. This was achieved by reliance on local materials on sub-structures.

It is acknowledged that further efforts in the technical design, cooperation with local engineers, artisans and material suppliers along with mobilisation of local stakeholders is needed to increase affordability. Still, the from-waste-to-wealth aspect of the UDDT has certainly added an unprecedented motivation for toilet ownership potentially unlocking major development backlog in the sanitation sector.

KEY WORDS: COST-EFFICIENCY, CO-DESIGN, NUTRIENT RECYCLING, URINE DIVERSION DRY TOILET (UDDT)

DRY TOILET 2015

5th International Dry Toilet Conference

Introduction

The case study area, Ho Municipality, is located in Volta Region in the South-Eastern part of Ghana. Ho town is the capital of the municipality and the regional capital of Volta Region. A state of sanitation study made in 2012 as a part of the Municipal Environmental Sanitation Strategy and Action Plan (MESSAP) revision process revealed that the number of private toilets in Ho Municipality was 6346 while the estimated population was approximately 284 000. Majority uses public latrines, but about half of the zonal councils do not have any public latrines. (Ho Municipal Assembly 2012.)

In Ghana, the Millennium Development Goal for access to water has been met, but with the current trends, the proportion of the population with access to improved sanitation will reach a mere 21.2 per cent by 2015 instead of the targeted 52 per cent. (UNDP in Ghana 2015.) Approximately 20 per cent of the population is practicing open defecation, nine per cent use unimproved sanitation facilities and over half of Ghanaians depend on shared facilities. (UNICEF & WHO 2012.) The consequences of poor sanitation are estimated to cost US\$290 million annually (WSP 2012).

To address the issue, Community-Led Total Sanitation (CLTS) program has been initiated nationally in Ghana to discourage open defecation and encourage toilet building and ownership in communities. The CLTS approach targets at a behavioural change in the whole community through community mobilization instead of investment subsidies. Aim is that the community members themselves realize the negative effects open defecation (OD) has on their community and health, and make the decision to become open defecation free (ODF). (Institute of Development Studies 2011.)

Since September 2012, the implementation of CLTS has proceeded gradually with the support from UNICEF in the communities of Ho with an aim of announcing the whole municipality open defecation free. There are ten teams of two, altogether 20 environmental health officers, involved in CLTS outreach in Ho. (Kettunen 2014.) North-South Local Government Cooperation of City of Lahti in Finland and Ho Municipal Assembly have identified total sanitation as a long-term objective of the cooperation. In 2013-2014, one of the aims of the cooperation was to capacitate officials in advocating Urine-Diversion Dry Toilet (UDDT) to communities as a part of the ongoing CLTS program in Ho.

While the CLTS is providing the means and resources for the officials to handle consistent on-site advocacy on sanitation issues in all communities, it does not attempt to deliver technical knowhow and capacity building on suitable toilet models. Therefore, North-South cooperation opted for complementing CLTS by co-designing toilet models that would be locally suitable and sustainable. At the moment, the advocated sanitation facilities for rural areas in Ho are Kumasi Improved Ventilated Pit toilets (KVIP), Mozambique lined, Mozambique unlined, Samplat and Rectangular pit latrines. The cultural acceptability of these pit latrine technologies is low due to the offensive odours and hot vapour that are associated with spreading of diseases. Also, stony ground or water-logging have hindered toilet construction in some areas. The pathogen isolation and destruction capacity of the facilities is also poor, especially in the rainy season. (Sewor 2012.)

The focus in this research paper is on the technological design process and the implications of the technological appropriateness of different sanitation solutions for the conditions of Ho. The paper outlines the collaborative technical design process of UDDT for households in Ho in 2013-2014. The aim is to evaluate the success and shortcomings of the co-design process and its results, i.e. the technical design, to determine whether it would be feasible to advocate the household UDDT models to the communities in Ho. In addition, the potential for further technological modifications with emphasis on cost containment measures is evaluated and recommendation are given for the next steps in the co-creation process.

Background: Lessons Learned from Institutional UDDT Pilot

The need for a locally suitable toilet design taking into account the economic, socio-cultural, technical and environmental contexts was the key driver for the institutional UDDT pilot launched in 2009 as a

DRY TOILET 2015

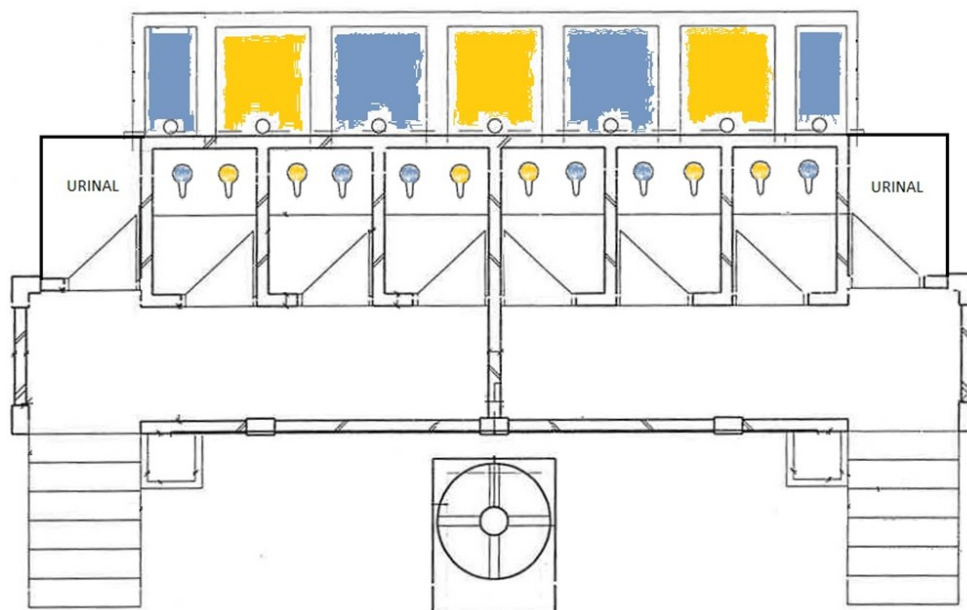
5th International Dry Toilet Conference

part of the North-South Local Government Cooperation. In this chapter, the institutional design is introduced along with summarised results of the studies conducted to gain understanding of the sustainability and suitability of the UDDT solution in the context of Ho compared to other improved sanitation options. At the moment, UDDT facilities have been constructed in seven schools in Ho Municipality; the cooperation with co-funding from Ho Municipal Assembly has supported the construction in six schools while one private school has adopted the technology independently.



Picture 1. UDDT at Ho Poly Primary Basic School (Aalto, 2014.)

As the name implies, the UDDT model is based on urine diversion and onsite-composting. The on-site composting of faecal matter is based on alternative use of the two squatting pans connected to different compost vaults. As demonstrated in Picture 2, there are two squatting pans in every toilet room; while the yellow ones are in use, the blue ones are closed and vice versa. The alteration cycle is one year allowing sufficient time for the compost to mature in the closed vaults. (Järvelä 2012, 35.) Urine collected from toilet rooms and urinals is piped to two tanks on both sides of the toilet building. The urine tanks are air-tight, thus preventing evaporation and nitrogen loss from the tank during storage time. It has been locally tested that urine needs to be stored a minimum of one month to ensure that the urine is sanitized (Kauhanen, Mäkelä, Järvelä & Aalto 2012, 17 & 33).

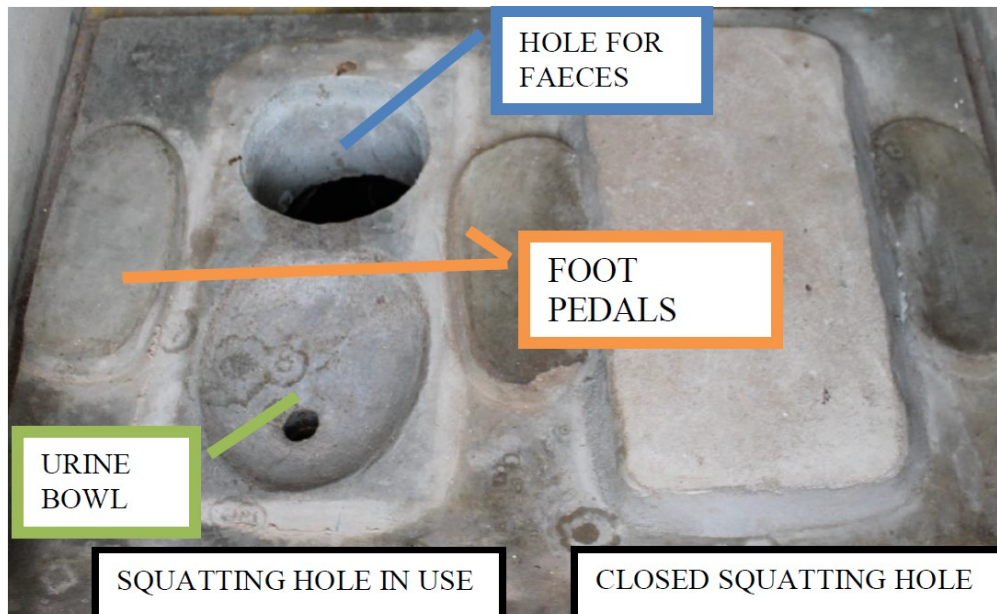


Picture 2. Institutional UDDT model in Ho, view from above (Osmonen, 2014.)

DRY TOILET 2015

5th International Dry Toilet Conference

The UDDT is divided into two sections: one section for boys and other for girls. Both sides have several toilet rooms with two alternatively used squatting pans in every room. The squatting model was chosen for hygiene and cultural reasons. The toilet facilities also have a rain water collection system for hand washing. However, dry season can cause shortage of water. (Kauhanen et al. 2012.)



Picture 3. Squatting model with alteration and urine diversion (Aalto, 2014.)

Financial Sustainability

It has been established that the construction costs of an institutional UDDT are not significantly higher than the costs of constructing an institutional KVIP – a model generally recommended to schools in Ghana due to low costs. However, the exact cost difference can vary based on terrain and design details. In addition, the operational and maintenance costs of UDDT are estimated to be lower than in any other recommended model due to low emptying costs. (Järvelä 2012.)

In addition, the UDDT is actually creating value out of waste as the separated urine and compost can both be used in small-scale agriculture. In rural communities of Ho, majority depends on small scale, self-sustaining agriculture and many of the farmers are unable to buy commercial fertilizers. The field trials and demonstrations with urine fertiliser have been carried out in 2011-2014 by Ho Polytechnic Agricultural Engineering Department and since 2013 the Ministry of Food and Agriculture (MoFA). The experts have concluded that urine fertilizer can provide equal or even better yields than commercial fertilisers. In the test conducted in 2011, the use of urine fertiliser increased the yield of cabbage, garden egg and pepper 21-40 per cent compared to control field and 6-13 per cent compared to a field fertilised with commercial fertiliser. (Akah, Bosrotsi, Järvelä & Siri 2012; Akah, Bosrotsi, Aalto & Asuo 2015.)

Social Sustainability

In user inquiries conducted in 2011, it has been found that 95 per cent of the users find dry toilet to be hygienic and comfortable to use. Especially, the lack of offensive smells has been seen a great benefit. Odourless UDDT is convenient to use, does not attract flies and moreover, moisture levels of the compost are too low for fly breeding. When asked which sanitation facility the users would want to have in their own house, 67 per cent preferred UDDT while the rest wanted a WC. Based on the user inquiries, nobody preferred KVIP for schools or homes which is in line with earlier findings indicating poor cultural acceptability. (Järvelä 2012.)

DRY TOILET 2015

5th International Dry Toilet Conference

Technical Sustainability

In general, there are two main technical criteria for assessing the sustainability of a sanitation solution: disease prevention and simplicity. In other words, the sanitation system must be capable of destroying or isolating faecal pathogens, and be robust enough to be easily maintained with the limitations of the local technical capacity, institutional framework and economic resources. (Järvelä 2012.) The UDDT facilities are locally produced with local experts and no parts are imported. The locally-led design and construction process are key features in ensuring e.g. the capacity for repairs which notably adds to the technical sustainability of the facility.

As there is currently no post-treatment of sludge in Ho, UDDT is the most effective technical solution for pathogen isolation and the only solution that ensures the destruction of the pathogens. Laboratory tests in Ho have shown that UDDT can destroy the pathogens of toilet waste sufficiently and makes it safe for the re-use (Akah et al. 2012). The facility isolates the waste, so that there is no contamination on surrounding environment. However, this is possible only if the facility is operated and maintained correctly which requires education and involvement of the users. (Järvelä 2012.) It is also suitable for all kinds of locations, whereas the KVIP and the septic tanks cannot be constructed to areas that are easily flooded, have high groundwater tables or to areas with clay or hard rock. Furthermore, WC technology requires connection to water pipe system and therefore it cannot be used in areas with frequent water flow problems. Due to lack of water connections and high costs, WC is generally not even advocated to rural areas. (Järvelä 2012.)

Table 1. Technical comparison of the toilet facilities in Ho Municipality (Järvelä 2012.)

	DT	KVIP	WC
Pathogen isolation	++	-	+
Pathogen destruction	++	--	-
Easily constructed	-	+	--
Easily maintained	-	++	-
Suitability for different conditions	+	-	-

Scale: -- - + ++

Organisational Sustainability

Ho Municipal Assembly has shown their committed to the ecological sanitation development by adding the UDDT technology to their Municipal Environmental Sanitation Strategy and Action Plan (MESSAP) as well as by co-financing four UDDT facilities constructed during 2012-2014. Perhaps the most notable acknowledgement is the fact that Ho Municipal Assembly has stated they will recommend UDDT for all new schools under constructions. All new schools are obligated to build a toilet while existing schools without toilets are often waiting for donations. In case of new donations, the municipal engineers are also prepared to recommend the UDDT. (Aalto 2015.)

Environmental Sustainability

As already noted in technological scrutiny of the facilities, in the absence of post-treatment facilities for sludge, UDDT is the most effective sanitation model in pathogen isolation and destruction. Furthermore, the model preserves fresh water resources and allows management of natural nutrient cycle. Closing the nutrient cycle supports sustainable local agriculture and reduces the use and reliance on imported, commercial fertilisers that are produced with significant environmental impact.

Designing and Piloting Household Models

Considering the economic restrictions, lack of sewage treatment facilities and occasional water supply shortages, it is clear that WC technology is not going to solve the sanitation challenge in Ho Municipality any time soon. Meanwhile, pit latrine technology suffers from high ground water table, rainy season runoff and especially the lack of user convenience and cultural acceptability. By offering the solution to these common problems, UDDT technology has the potential to assist the municipal officials of Ho in their quest for increased sanitation coverage. Ending open defecation can protect the water sources from contamination and excess nutrient run-off.

The from-waste-to-wealth aspect of the UDDT has added a significant motivation for toilet ownership potentially unlocking major development backlog in the sanitation sector. Radio outreach conducted in Ho during late 2014 concerning the effects and use of urine fertiliser was met with keen interest and numerous inquiries were made to the Assembly office related to UDDT. The response from the farmers involved in the 2014 field demonstrations in 16 communities has been equally positive with ninety seven percent (97%) of interviewed farmers and Technical Officials involved in the demonstrations (120 interviewed) indicated that they have decided to start storing their own urine for use in growing their crops in future. There is definitely fast progress made with the establishment of user-base for urine fertiliser and the involvement of Ministry of Food and Agriculture (MoFA) has been a key factor in mobilisation of the farmers. (Akah et al. 2015.)

After the establishment of local suitability of the UDDT model in institutional setting, discussion was initiated concerning the potential for promoting UDDT for households in Ho. As a part of a Dry Toilet –Manual compilation process, a two-seater institutional model was designed in 2011. This design was intended to be suited also for households. The UDDT had two toilet rooms with three compost vaults below allowing on-site composting. The design was planned for two families, each with their own toilet rooms. (Järvelä 2012; Kauhanen et al. 2012.) Even though the design has been available, it was noted that stakeholder involvement was needed to move forward and encourage adoption.

Despite interest, the lack of household UDDTs and limited available technical designs have been hindering the resource mobilization. Sure there are institutional models, but the user-base and durability demands are raising the relative costs of these models high. Ultimately, redesigning the UDDT for households with a focus of cost containment was needed. CLTS approach is demanding the officials to advocate the most affordable options which is creating barriers to cooperation with regional agencies if the costs are not cut significantly. All in all, it was concluded that pilot models are needed for demonstration purposes as well as for determining the actual costs and preferable design features in practise.

Phase 1: Stakeholder Involvement

In June 2013, a workshop was organised to Environmental Health Officers (EHO) of Ho Municipal Assembly to discuss and plan the potential of different expansion options of the UDDT technology in Ho Municipality. Twenty-two (22) officials took part in the workshop that included presentations, group work and final discussion. (Aalto, 2013.)

When discussing the technical options of dry sanitation, it was apparent that the officials preferred a dry toilet model with urine diversion and two vaults allowing onsite composting. It can be argued that this is the only dry toilet design they are accustomed to and thus prefer it over e.g. one vault models and composting toilets without urine diversion. Nevertheless, the recommendation from the officials is based on clear motivations such as the agricultural interest in urine fertiliser and the perceived cultural suitability of the onsite composting with less need to handle raw faeces. One of the emphasised beneficial features of UDDT is the lack of offensive odours due to the diversion of urine which is setting UDDT apart from KVIP and pit latrine models (Aalto, 2013).

During the workshop, the officials were asked to detect challenges which hinder the diffusion of UDDT technology for households. The main challenges named were lack of skilled latrine artisans and

DRY TOILET 2015

5th International Dry Toilet Conference

the inability of the households to cover the initial costs of the construction. (Aalto, 2013.) As a conclusion of the workshop, a training program for local artisans was planned in collaboration between Environmental Health Officials (EHOs) and work placement students from Lahti University of Applied Sciences. The students gathered the basic requirements of UDDT technology and various technical examples for a training material and executed a training event for local artisans in August 2013 together with EHOs.

The training included a two-day workshop with site visits and theoretical training where 13 artisans selected by EHOs participated. The artisans represented different communities in Ho and were chosen based on their previous experience in building sanitation facilities. The training was also utilised to gain insight on the cost containment options in the building process. The artisans designed in groups a low-cost UDDT option based on the theoretical training and their own expertise. All the groups designed a simple UDDT with a lasting concrete foundation to ensure durability of the latrine. The low-cost aspect was implemented by using cheap local materials in the walls and in the roof. Considering costs, a squatting model was preferred, but also a wooden bench-style model was suggested as seated model is generally preferred for households. (Kettunen & Osmonen 2013.)

Based on the feedback, the artisans found the training beneficial and majority expressed that they could utilise the gained information in their work and would be able to educate the communities on the UDDT concept with a prospect of personal job creation. Still, a need for hands-on practical training and the need for detailed technical drawings was emphasized. (Kettunen & Osmonen 2013.)

Phase 2: Technical Design Based on Literature Review

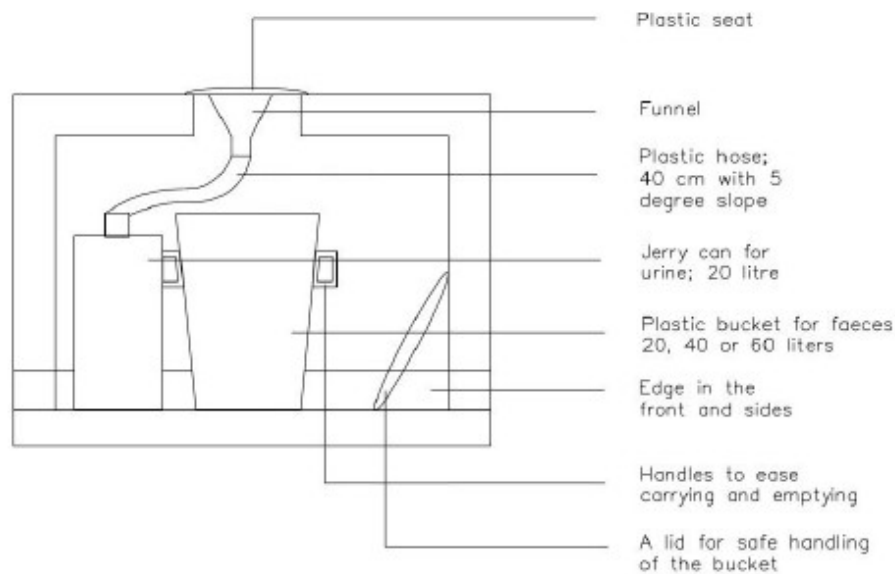
The search for a suitable household UDDT model was continued as a final thesis research conducted as a literature review and complemented by data from interviews with municipal officials and engineers from Ho. The purpose of the study was to design two UDDT models for the households in urban and rural settings. In the literature review, different dry sanitation models including a single-vault, bucket system, double-vault and rotating system were compared and their suitability for standard urban and rural families was evaluated. (Kettunen 2014.)

To begin with, a standard urban and a standard rural family were defined in the study to estimate the needs and user requirements as well as to scale the facility. Based on statistics and interviews with officials, a standard urban family was defined as a single parent family of four with an annual income of 6000 Ghana Cedis (less than 1700 euros based on 2014 exchange rates). Typical rural family was defined having five members and being involved in small-scale agriculture with annual earnings of 1200 Ghana Cedis (around 330 Euros based on 2014 exchange rates). The obvious implication of the standard income levels is that the initial investment needs to be minimised, especially in rural areas. (Kettunen 2014.)

Based on the literature review and the imperative of cost containment, the recommended model for rural areas was a urine diversion toilet with a bucket system based off-site composting. It is recommended that the buckets are emptied to a communal compost container to provide soil amendment material for the persons responsible for maintaining the compost. A bucket toilet is the most affordable of all potential UDDTs studied. The model has a very compact unit, which can be built against an existing house. If the family can provide materials and labour force, the building costs can be reduced even more. Similar pan latrines have been traditionally used in Ghana without the compost treatment. This traditional pan latrine system is no longer advocated. On the contrary, the intension is to phase out the system and it is currently forbidden to build new pan latrines. It is unclear whether the bucket UDDTs with an off-site compost container could be approved in the Ghanaian policy context. (Kettunen 2014.) So far the officials have been hesitant to start a dialogue with the regional ministry concerning the option due to fear of creating a negative image for the whole UDDT concept.

DRY TOILET 2015

5th International Dry Toilet Conference

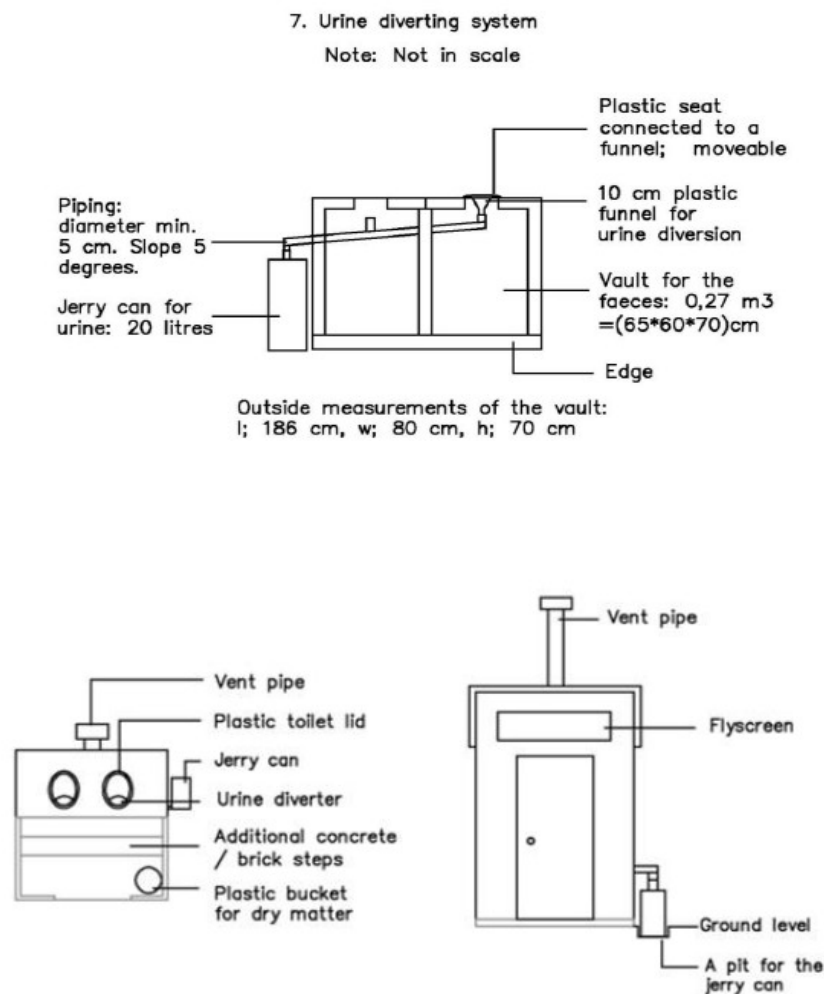


Picture 4. Recommended model for rural UDDT with off-site composting (Kettunen 2014.)

The recommended model for the urban settlements is a double-vault UDDT system with onsite composting. In high density urban areas, off-site composting is not feasible which excludes bucket composting option. Likewise, in the rotating system, compost might not be mature when the system needs to be emptied and off-site composting option is needed. Furthermore, onsite composting is more hygienic than the other models as there is less contact with raw faeces. Especially, the single-vault system has a risk of raw faecal matter mixing with the mature compost. It also requires more turning than the other compost systems. A part from lower maintenance requirement, the double-vault system is more affordable compared to the other systems based on the literature review. (Kettunen 2014.)

Even though the people in urban settlements are more likely to have better income compared to rural settlements, many potential cost containment measures have been designed also for the urban UDDT model. One of the key design drivers was the idea to minimise the use of concrete, which called for detailed estimations of the optimal capacity of the vaults. Kettunen (2014) also introduced the idea of placing the toilet seat right on top of the vault as a bench-model. This lowers the height of the building as the toilet room is not build entirely above the vaults. Also, there is no need for procuring or constructing separate toilet seats. The bench-model concept is also applied in the recommended rural UDDT model. To cut the costs of the tanks, the urine is collected to jerry cans in both models. Jerry cans are easy to handle, switch, store and obtain. The jerry can is placed into a small lined pit next to the facility in case of an overflow. (Kettunen 2014.)

All in all, the materials used in the design are meant to be durable and withstand all kinds of weather. The walls, floor and vaults are made out of concrete. Concrete vaults are also needed to prevent water from entering the vaults. The door for the entrance is wooden, while the vaults' doors are made out of metal. Both are painted against rust and weather damage. The roof of the facility is made with metal sheets. The toilet seat and the lid are plastic. The urine diverter attached to the seat and the piping used for conducting urine are also made out of plastic. Plastic was selected because it is an inexpensive material, easy to replace and endures urine well. There should be a five degree slope on the piping to avoid stagnation. To reduce ventilation, odours and nutrient loss from the urine, the end of the pipe should be placed 7.5 centimetres from the bottom of the jerry can. The vent pipe is PVC or other plastic material. (Kettunen 2014; Wateraid 2011, 46.)



Picture 5. Recommended model for urban UDDT with double-vault (Kettunen 2014.)

Phase 3: Artisan Training and First Pilot Model

The first UDDT pilot for households was built in Akrofu Xeviwofe community located approximately 15 km from Ho Town. The community was chosen due to high ground water tables that have restricted the use of KVIP in the area. A number of KVIPs have been constructed in schools and homes in Akrofu Xeviwofe, but they are not used regularly since the pits are often filled with water causing an apparent contamination risk. Second selection criteria was the fact that the community had already been involved in a field trial for urine fertiliser in 2013 and the concept of organic fertilisers had also been introduced via community-led biowaste composting pilot since 2012. (Järvinen & Haikola 2014.)

The UDDT model was designed by the municipal engineers together with the end-user of the facility. The engineers had been advised to aim for low-cost model without jeopardising the user convenience and durability. The team had the information collected in phase 1 and 2 to guide the design process; still a lot of the suggested cost-cutting measures, such as the bench-model, were not implemented to the design. It turned out that many of the suggestions were not well-understood and it was noted that the practical training for the engineers in UDDT was not sufficient for making significant redesigns of the original institutional model. (Järvinen & Haikola 2014.) The situation was partly due to the transfers of key personnel that had contributed to the loss of UDDT expertise in the department.

DRY TOILET 2015

5th International Dry Toilet Conference

As a result of unfavourable material price fluctuation during the construction process and the lack of cost-cutting measures, the cost of the facility was ultimately 8 346.00 GHS which at the time amounted to approximately 1 800 Euros in material costs. The rising price of concrete had significant impact on the total costs, as the estimation from 2011 put the cost of two-vault UDDT in 5 213.50 GHS (Järvelä, 2012). The facility was undoubtedly built to last with a robust structure and an estimated use-time without major renovations of at least 30 years. The design also catered to user convenience with a large tank for urine collection and urine separation toilet seats modelled from concrete. (Järvinen & Haikola 2014.) Still, with such a significant initial investment cost, it was concluded that the UDDT model as such is not feasible for the communities and more technical design efforts are needed before advocacy can be started.

Phase 4: Redesign in Co-creation Process

After the first construction, the cost containment issue was discussed in depth with the cooperation working group and municipal engineers. Furthermore, the first household UDDT pilot was introduced to the whole Environmental Health Unit in November 2014 during a workshop. Overall, the first UDDT design raised mixed feelings. On one hand, the officials and engineers were proud of the first design; the UDDT in Akrofu Xeviwofe is indeed a robust facility with user-friendly maintenance features. On the other hand, it was acknowledged that the issue of investment costs cannot be overlooked if the facility is to be promoted to the communities.

As the main cost factor seems to be concrete, the decision was made to try out local materials estimated to have similar durability characteristics as concrete. With the use of locally produced mud-bricks, the cost of materials amounted to less than 4 000 Cedis. Although, the labour needs were significantly higher, the price of materials was halved by reliance on local materials on sub-structures. This building process involved five artisans with theoretical training, adding the total of artisans with practical UDDT training to ten. Costs were also cut by choosing a squatting model. Based on the redesign, a second household UDDT was built at Godokpe in December 2014. The area has a stony surface that is preventing the use of septic tanks and pit latrines alike.



Picture 6. Second household UDDT in Ho (Pictures by John Datsa 2014.)

Analysis: Success Factors and Challenges

When considering technological factors, cost, durability, feasibility of use, and maintenance requirements have all been mentioned as key factors to sustained adoption of a sanitation solution. Furthermore, in low- and middle-income countries, the initial investment requirement is of great significance to users. The bottom-line is that if the investment cost is too high, the adoption of the technology is not feasible despite any other motivational factors. Finally, the appropriate, user-friendly design that takes into account the ease of routine upkeep and maintenance as well as additional features e.g. to assist with menstrual management or child-friendly latrine pans, have significant impact on the continued use, as they enable the individual to feasibly use the sanitation solution on a routine basis. (Hulland, Martin, Dreibelbis, Winch et al. 2014.)

In Ho, the collaborative design process has enabled success in the aspects of durability as well as feasibility of use and maintenance. However, there is still work to be done concerning the initial investment cost. Fluctuating material prices, monitoring distance and locals' unfamiliarity with the household-oriented UDDT technology have formed challenges to the design process and the intention is to continue the co-designing process in the coming years as the expertise is accumulated. A key concern is developing the capacity of the municipal engineers in ecological sanitation design and cost containment. With practical technical training on the various UDDT options and solutions, the engineers could contribute more to the design process as well as monitor and guide the next steps of the artisan trainings. In hindsight, a more systematic inclusion of the municipal engineers should have been implemented from the outset.

In the next steps of the design process, the focus needs to be on frugality i.e. achieving more with fewer resources. Basic toolkit for frugal innovations suggests that the main issue to focus on are affordability, customer-driven evaluation of product features as well as re-constituting the value chain by nurturing new partnerships. The second consideration, product features, guides us to focus on the critical considerations that the customer has with regard to the fulfilment of the need. In other words, any features that add costs, but are inconsequential to the fulfilment of the need, are futile. The reshaping of the value chain in turn refers to e.g. partnerships that could ensure the acceptance of the innovation by target customers. (Mukerjee 2012.) All in all, designing frugal innovations requires a sense of local needs and value systems. It is necessary that the local end-users or at least the engineers grown in said local context are involved in the design process to ensure the relevance of product features, the perceived affordability and the relevant value chain.

Conclusion

As the Ghanaian colleagues phrase it, 'it might be simple, but it is not easy'. The UDDT facility is a simple structure which is a strength. From simplicity comes durability and ease of maintenance. Simplicity also lowers costs. Nevertheless, UDDT is a new technology locally and introduction is bound to come with a few setbacks. The final design or designs are still in the making. Still, in the North-South cooperation with a wide stakeholder platform, we are in an excellent position to co-create the whole structure and the related value-chains holistically in the spirit of frugal innovation.

It is acknowledged that further efforts in the technical design, cooperation with local municipal engineers, artisans and material suppliers along with mobilisation of local resources via relevant stakeholders is needed to increase affordability. Still, the from-waste-to-wealth aspect of the UDDT has certainly added an unprecedented motivation for toilet ownership potentially unlocking major development backlog in the sanitation sector. Waste is no longer viewed a problem, but as a resource.

References

Aalto, A. 2013. Sanitation Workshop –Report. Kekeli Hotel, Ho. 13.6.2013. North South Local Government Co-operation 2013-2014. City of Lahti –Rustenbun & Madibeng –Ho Municipal Assembly.

DRY TOILET 2015
5th International Dry Toilet Conference

Aalto, A. 2015. Self-Evaluation of Management and Impact of Development Cooperation North-South Local Government Cooperation 2013–2014 Lahti (Finland) –Rustenburg & Madibeng (South Africa) – Ho (Ghana). Association of Finnish Local and Regional Authorities.

Akah, S., Bosrotsi, C., Järvelä, E. & Siri, M. 2012. Utilization of Diverted Urine from Dry Toilet Systems for Vegetable Production in the Ho Municipality, Ghana. Poster presentation. International Dry Toilet Conference 2012. Global Dry Toilet Association of Finland.

Akah, S., Bosrotsi, C., Aalto, A. & Asuo, S. 2015. From Waste to Wealth and Health: Evaluation and Community Appreciation of Human Urine as Fertilizer in Ho Municipality of Ghana. International Dry Toilet Conference 2015. Global Dry Toilet Association of Finland.

Institute of Development Studies 2011. The CLTS approach. Community-led Total Sanitation Programme [referenced 16.10.2013]. Available: <http://www.communityledtotalsanitation.org/page/clts-approach>

Ho Municipal Assembly 2012. Municipal Environmental Sanitation Strategy and Action Plan (MESSAP). Ho Municipal Assembly: MPCU.

Hulland, K., Martin, N. Dreibelbis, R. & Winch, P. 2014. What factors affect sustained adoption of sanitation interventions? Summary report drawn from systematic review of literature. EPPI-Centre Social Science Research Unit Institute of Education. University of London. [Referenced 10.4.2015]. Available: http://www.coregroup.org/storage/Webinars/WASH/sanitation_v4_nm_04aug2014.pdf

Järvelä, E. 2012. Feasibility of the dry toilet technology in Ho Municipality in Ghana. Master's Thesis [referenced 10.1.2014]. Available: http://www.lahti-bojanala.net/assets/files/DT_Thesis2012_Jarvela.pdf

Järvinen, J. & Haikola, H. 2014. Kuivakäymäläteknologian pilotointi kotitalouksille. Tapaustutkimus Ho:n kunta, Ghana. Lahden ammattikorkeakoulu. Tekniikan ala. Ympäristöteknologia. Ympäristönsuojelutekniikka. 30.9.2014.

Kauhanen, M., Mäkelä, J., Järvelä, E. & Aalto, A. 2012. Dry toilet manual – Case Ho Municipality, Volta Region, Ghana. Lahti Science and Business Park. [Referred 16.10.2014.] Available online: <http://www.lahti-bojanala.net/index.php?id=310>

Kettunen, P. & Osmonen, E. 2013. Artisan Training- Report. Kekeli Hotel, Ho. 13-14.8.2013. North South Local Government Co-operation 2013-2014. City of Lahti –Rustenburg & Madibeng –Ho Municipal Assembly.

Kettunen, P. 2014. Introducing Dry Toilet Technology to Households. Case: Ho Municipality, Ghana. Final Thesis. Lahti University of Applied Sciences. [Referenced 14.4.2015]. Available: <http://urn.fi/URN:NBN:fi:amk-201404164430>

Mukerjee, K. 2012. Frugal innovation: the key to penetrating emerging markets. IVEY Business Journal. July/August 2012. [Referenced 14.4.2015]. Available: <http://iveybusinessjournal.com/publication/frugal-innovation-the-key-to-penetrating-emerging-markets/>

Osmonen, E. 2014. Choosing a Dry Toilet Model for Public Use Case: Ho Central Market, Ghana. Lahti University of Applied Sciences. Degree programme in Environmental Technology. Final Thesis. [Referenced 14.4.2015]. Available: <http://urn.fi/URN:NBN:fi:amk-2014060912208>

Sewor, P. 2012. Dry toilet technology implementation in Ho Municipality, Ghana - Solution to pit latrine problems. Poster presentation. International Dry Toilet Conference 2012. Global Dry Toilet Association of Finland.

Trift, C. 2007. Sanitation Policy in Ghana: Key factors and the potential for ecological sanitation solutions. EcoSanRes Programme. Stockholm Environment Institute. Stockholm. 29 p.

DRY TOILET 2015
5th International Dry Toilet Conference

UNDP in Ghana 2015. Ensure Environmental Sustainability. [referenced 28.4.2014]. Available: <http://www.gh.undp.org/content/ghana/en/home/mdgoverview/overview/mdg7.html>

UNICEF and WHO. 2012. Progress on drinking water and sanitation [referenced 28.4.2015]. Available on: <http://www.unicef.org/media/files/JMPreport2012.pdf>

WaterAid 2011. Construction of ecological sanitation latrine - Technical handbook. WaterAid, Nepal. [Referenced 28.4.2015]. Available: http://www.susana.org/_resources/documents/default/2-1498-latrine-construction--19-oct-2011.pdf

WSP. 2012. Economic impacts of poor sanitation in Africa [referenced 28.4.2015]. Available: <https://www.wsp.org/sites/wsp.org/files/publications/WSP-ESI-Ghana-brochure.pdf>