การรับรู้และการทดสอบการใช้งานโถสุขาเคลื่อนที่สำหรับอุทกภัย

Community Perceptions and Usability Testing of Portable Toilet Bowl for Flooding

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บทคัดย่อ: *ปัญหาหลักประการหนึ่งเมื่อเกิดเหตุอุทกภัย คือปัญหาด้านสุขอนามัยโดยเฉพาะอย่างยิ่งปัญหาด้านการขับถ่าย มีการคิดค้นโถสุขภัณฑ์ฉุกเฉินหลายๆ รูปแบบ เพื่อแก้ไขปัญหาการขาดแคลนห้องน้ำ รวมถึงโถสุขภัณฑ์กระดาษที่มีข้อดีคือมีราคาถูก น้ำหนักเบา สามารถขนส่งได้ง่าย แต่อาจมีปัญหาในเรื่องของเจตนคติในการใช้งานของโถส้วมร่วมกับสารดูกลิ่นและความชื้น จากการสำรวจภาคสนามเพื่อค้นหาเจตคติในการใช้โถสุขภัณฑ์กระดาษด้วยแบบสอบถามกับกลุ่มตัวอย่างในพื้นที่ที่ประสบปัญหาอุทกภัยในเขตจังหวัดสุพรรณบุรี เกี่ยวกับพฤติกรรมการขับถ่ายในยามเกิดอุทกภัยพบว่ากลุ่มตัวอย่างไม่ยอมรับการถ่ายซ้ำบนอุจจาระผู้อื่น และไม่ยอมรับการถ่ายซ้ำบนอุจจาระตนเอง แต่สามารถยอมรับได้มากขึ้นเมื่อมีการโรยทับอุจจาระด้วยสารดูดกลิ่นและความชื้น หลังจากนั้นได้นำโถสุขภัณฑ์ต้นแบบไปให้กลุ่มตัวอย่างทดลองใช้งาน ภายหลังการใช้ได้มีการจัดสนทนากลุ่มเพื่อสอบถามประสบการณ์ และปัญหาที่เกิดขึ้นจากการใช้งาน พบว่ากลุ่มตัวอย่างส่วนใหญ่มีความกังวลกับโถสุขภัณฑ์ที่มีการใช้ถุงอุจจาระซ้ำเกินกว่า 2 ครั้งและถุงอุจจาระไม่ควรปะปนกับของผู้อื่นสำหรับการจัดเก็บถุงอุจจาระไว้ในครัวเรือน เพื่อลดปริมาณขยะในช่วงอุทกภัยเป็นเรื่องที่ยอมรับได้หากมีการจัดเก็บอย่างมิดชิด แต่ยังมีความกังวลกับการนำอุจจาระเป็นปุ๋ยสำหรับการเพาะปลูก*

One main problem of flooding is sanitation issue, especially sanitized excreta. Several types of portable toilet have been designed to solve the problem of toilet shortage in flooding area, including paper toilet bowl as one option due to its light-weight, inexpensive production and convenience for transportation. However, it still has some problems in terms of attitude towards the usage of paper toilet, and deodorized and dehumidified powder. To investigate the perception of people towards the use of the product, field investigation was conducted in Supanburi province. According to the preliminary questionnaire, subjects did not agree to defecate over others' feces, and they did not agree to defecate over their own discharges. With the powder for excreta, the acceptance rates increased in both cases. Then the focus group tested the paper toilet bowl. They reported the problems that occurred. The interview showed that most of the sample did not agree to use excreta bag twice, especially the same bag with other people. There was no problem to store the excreta bag in their houses during flood but there was a concern on the use of the excreta as fertilizer.

คำสำคัญ: *Portable Toilet, Flooding, community perceptions, Ecological sanitation, Human Excreta*

1 INTRODUCTION

In the year 2011, Thailand and Bangkok encountered the most devastating flood in five decades and caught the entire nation off-guard. One of the problems happening then was toilet shortage. Many household toilets could not be used, since the water level was higher than the ground level for 40-200 centimeters[1]. The Red Cross and private sectors donated ten thousand

portable toilets for victims but this was still not enough. One of the sanitary problems was the human excreta since the flooding prolonged from one to two months. Many flooding victims did not want to move themselves to the evacuation centers because they wanted to protect their belongings. As a result, it was inevitable to keep the human excreta for a month without any treatment in households. The human excreta could thus pollute the water and environment in case it was thrown into the water resources.

Figure 1: Portable toilet [5]

Several toilet patents have been registered in the past such as Combination Packable Toilet and Stool[2], Collapsible or foldable seat for children[3], and a combined seat and toilet apparatus[4]. They are made of corrugated paper but none of inventors has integrated the defecate powder. Figure 1 shows the component of a portable toilet[5]. The toilet is a jigsaw component of three pieces of paper. For the environmental concern, the discretion bag is made of biodegradable material. In the year 2011, the Energy, Environment Safety and Health (EESH) at KMUTT produced the powder combined of Zeolite and Bentonite, packed into the degradable plastic bag. Both substances are of the volcano clay that is used for absorbing toxins. Bentonite also is used for skin to heal Ecszema, Dermatitis & Psoriasis. It also can be eaten to relieve digestive problems. As a result, the powder is safer than using Sodium Hydroxide. In the experiment with focus group, the subjects were informed directly how to use the powder. The EESH established the call center to support the flooding victims and received donated materials from public. Volunteers such as KMUTT students and people in nearby communities came to pack these portable toilet sets. The instruction of portable toilet bowl was placed on the side of portable toilet to demonstrate how to use the product (see figure 2). There are 4 steps of instruction. At the first step, users insert the plastic bag into the toilet bowl and tie the handle with the seat. For the second step, it shows how to wear the black bag as a raincoat while defecating.

For the third step, the powder is poured over the excreta by shaking powder? the excreta and powder together. Due to the limitation of substance, subjects must reuse the bag for 2-3 times without taking the bag out. The cover bowl must be closed to control the smell of excreta. For the fourth step, it shows how to use the feces as fertilizer with the safety instruction how to bury the whole discretion bag.

Figure 2: Instruction of paper toilet

From the meeting with the EESH officers, they preferred subjects to change their behavior during flooding. For example, they would like the flooding victims to reuse the discretion bag for several times and use less water to clean the discretion. From the survey, a lot of household did not have a proper toilet since the water level was high and defecate could not be flushed into the sewage treatment systems. Moreover, the rescue team neither had enough bags nor wanted to carry a lot of loads while commuting. With these requirements, there is no data whether or not the flooding victims followed the procedure of the product. For example, the defecate bag should be reused at least two times. Another example is that human excreta collection should be kept

for one month. Nevertheless, subjects may not accept the condition of this behavior. Due to Ajzen's[6] theory of planned behavior, which provides a framework for studying human action, excreta is waste and waste is only suitable for disposal[7]. Mariwah and Drangert [8] found that Ghana community has negative attitude to fresh excreta and the handling of it. People's attitudes and perceptions about excreta vary due to different cultures and even within specific cultures even though they know that reusing excreta for agricultural purposes saves expenditures for chemical fertilizers, improves soil fertility, reduces poverty and ensures food security. There is no study the attitudes of Thai community towards the excreta.

The first objective of this research is to explore the attitudes and usability of portable toilet and powder. It aims to examine the behavior of users in order to match product that fits their lifestyles. Another objective is to find an appropriate design of a portable toilet bowl.

2 METHODS

For this study, two steps of research were the questionnaire and focus group. The questionnaire was used to determine the acceptance of subjects towards themselves, communities and portable toilet bowl. Subjects had not used the toilet bowl before since researchers would like them to figure out how to use the product that they want instead of following the product functionality. Moreover, the difference of opinion before and after using the toilet bowl is interesting to study in terms of an attitude change. Then the focus group was the second process to verify the potential use of portable toilet and powder. The study area was situated at Suphan Buri province, on August 19, 2011. The population in Ban Laem district was 600 from 204 households.

2.1 Questionnaire

For this study, there were 204 households with the population of 600 people. The number of sampling was 94 with 33 males and 61 females. The average age was 59.4. They had an experience of the flooding level higher than 1 meter for two months. The majority of population graduated from elementary schools (82%) and high schools (13%). 52% of the career was agriculture, 31% self-employed and 11% merchants. The questionnaire was divided into three sections. The first section was about the subject's behavior of defecation. The second section asked about the aspect of community. The third section concerned the behavior related to the portable toilet and powder. The questionnaire used five Likert scale from 1 (disagree) to 5 (strongly agree) respectively.

2.2 Focus group

Ten subjects from five households participated in the experiment. There were seven males and three females in this study. An average age was 46 year olds. They received the paper toilet and the biodegradable plastic bags. The subjects were requested to separate the urine and feces since the urine causes fungus. Subjects were requested to record the data related to the behavior and inspection for 9 days.

3 RESULTS

3.1 Questionnaire

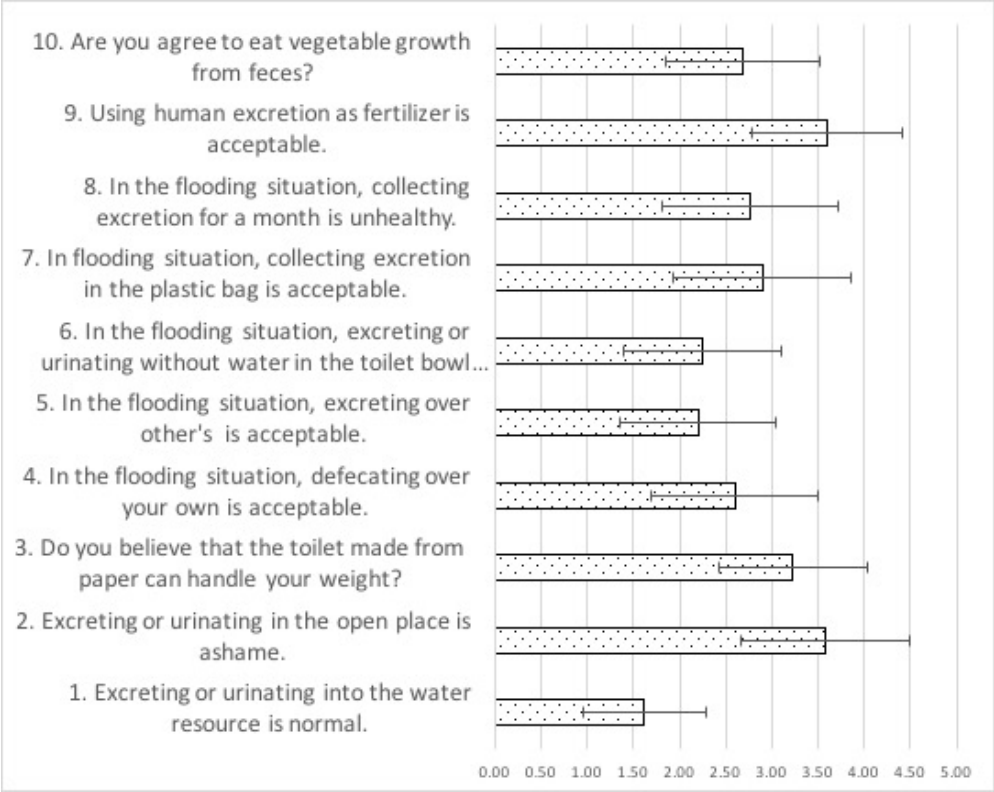

Figure 3 : General opinion on defecation

The results show that subjects had concerns on health and environmental problem. For the environmental problem, they did not agree to contaminate water resources with feces or urine (M=1.62, SD=1.34) as can be seen in figure 3. The score of collecting feces in the plastic bag is under average (M=2.89, SD=1.91). They also believed that collecting feces for a month was unhealthy (M=2.77, SD=1.9).

Many subjects did not agree on new behavior of defecation. For instance, to defecate over their own feces (M=2.6, SD=1.79) or others' (M=2.2, SD=1.68) was unacceptable. Some of the results reflect their previous experience, for example, to defecate and urinate without water in the toilet was unacceptable (M=2.24, SD=1.69). For the waste utilization issue, they accepted that feces could be fertilizers (M=3.61, SD=1.63) but did not agree to eat vegetables from these fertilizers (M=2.68,SD=1.68). Subjects accepted that feces could be used for other types of plant, not the vegetables.

The issues related to the portable toilet show that they believed the toilet made of paper could handle their weight (M=3.22,SD=1.61). Subjects felt ashamed if they excreted or urinated in open space (M=3.57,SD=1.84).

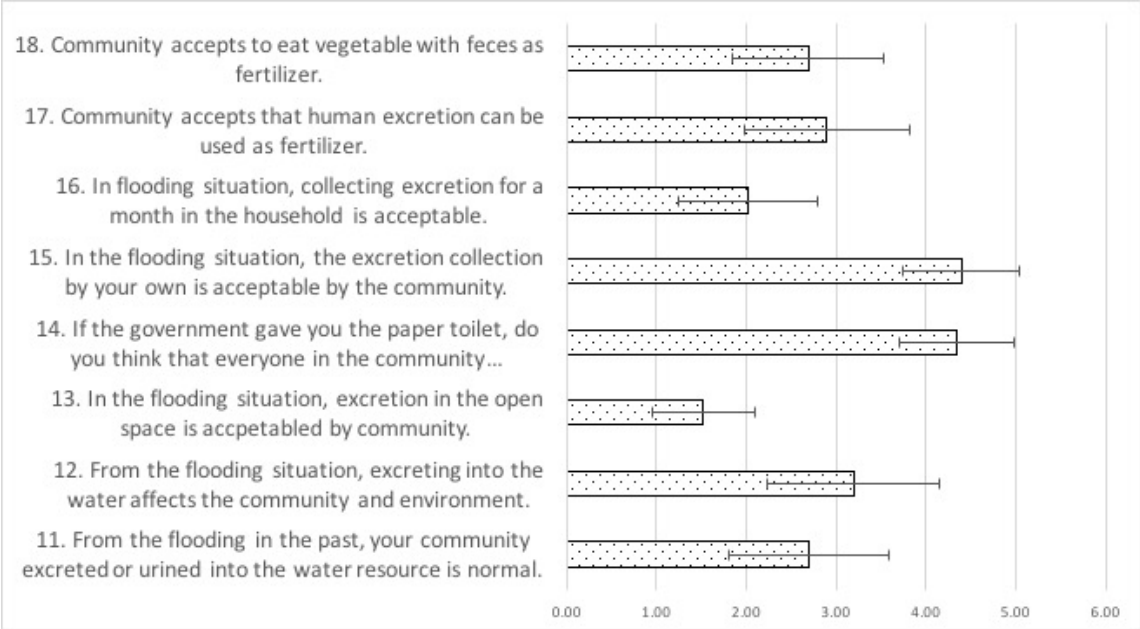

Figure 4 : Aspect of community

For the environmental issue, their community defecating or urinating into the water resources was not acceptable (M=2.69,SD=1.77) as can be seen in figure 4. Meanwhile they were aware that excreting into water while flooding affected the community and environment (M=3.19, SD=1.91). For the behavior of using toilet, the excretion in the open space was not accepted by community (M=1.52, SD=1.13). This is similar to subjects' opinion. For the portable toilet issue, everyone in the community accepted the paper toilet donated from government (M=4.34, SD=1.26). The excretion collection by their own was acceptable by the community (M=4.39, SD=1.29). On the other hand, collecting excretion for a month in the household seemed to be

unacceptable (M=2.02, SD=1.54). For waste utilization, subjects viewed that the community did not want to use feces for fertilizers (M=2.89,SD=1.84) and eat vegetables with these fertilizers (M=2.69, SD=1.68).

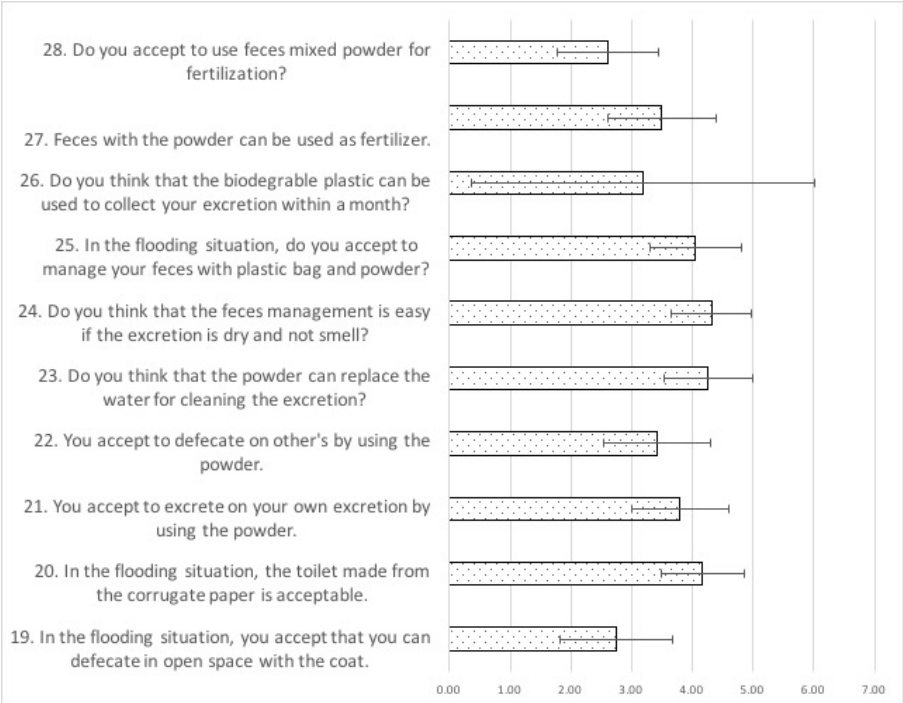

Figure 5 : Behavior related to portable toilet and powder

For the behavior of using toilet, the excretion in open space with coat was not fully accepted (M=2.76, SD=1.84) as can be seen in figure 5. This result has a similar direction to the first and second set of questions. On the other hand, the majority of group accepted the toilet made of corrugated paper (M=4.17 ,SD=0.69). Subjects accepted to excrete over their own (M=3.80,SD=1.59) and others (M=3.43,SD=1.75) by using powder than others (M=3.43,SD=1.75). The cause might be the convenience and privacy issues. They also thought that the powder could replace the water for cleaning excretion. This result supports that subjects require something to compensate the water cleaning method. If the feces is dry and does not smell, they can manage it by their own(M=4.32, SD=1.31). The plastic bag and powder could be used as a material for excretion management(M=4.05, SD=1.49). To collect the feces for a month with powder, subjects were satisfied to keep their feces with biodegradable bag (M=3.19, SD=5.99). Subjects also felt comfortable to use fertilizers mixed with the powder (M=3.5, SD=1.77) but they did not agree to use it for growing vegetables. This result has the same direction of the first and second set of question.

3.2 Focus group

Figure 6 : a) focus group, b) toilet after test, c) powder and discretion, d) bucket of all feces

The result shows that subjects threw the feces into the water resources when facing flooding in the past. The reason is that the municipal district rarely came to collect the feces. After subjects tested the paper toilet, some of them recommended that the size was too small and could not handle their weight and body. They preferred the rounded seat which was more comfortable. Subjects did not want to defecate over their own or others', despite the use of powder. They thought that the first and second time of defecation was acceptable but not for the third time. They preferred one time use instead. For the location of paper toilet, subjects placed it in the restroom and collected their excretion in the bin. They preferred to defecate in closed space such as restroom. They were satisfied with the powder since it could absorb the smell and moisture. For separating between urine and discretion, they used a urinal bottle with the paper toilet. They complained that the powder is too little. The powder weight should be more than 150 grams. For the fertilization from discretion, they were not confident enough to use it for agriculture but they agree to use it for landfill instead.

4 DISCUSSION

The result from the questionnaire shows that there is a significant difference on gender in the question number 3, 7 and 13. An independent sample t-test was conducted to compare the gender factor. There was a significant difference in the score for males (M=3.88, SD=1.386) and females (M=2.93, SD=1.621) conditions; t(92)=-2.831, p=0.004. Males believed that toilet made from paper could handle their weight more than females. In the same direction, there was a significant difference in the score of males(M=3.58, SD=1.838) and females(M=2.54, SD=1.867) conditions; t(92)=-2.579, p=0.01. Males believed that collecting excreta in the bag was acceptable than females. Females did not accept this condition. For the question number 13, there was significant difference in the score for males(M=2.03, SD=1.262) and females(M=1.28, SD=.958) conditions; t(92)=-3.206,p=0.002. Males believed that defecation in the open space was acceptable by community than females. Nevertheless, both genders did not accept this type of behavior. For the age and education level, there was no significant difference for all questions.

From both questionnaire and focus group, their responses are in the same direction in many ways. They concern both environmental problem and their comfort when using toilet bowl. For example, the defecate bag should be used for private only. As a result, the bag should be designed to be short and for one-time use. This will accommodate the logistic of product and user satisfaction. They also can manage and collect their feces by themselves. From the focus group, subject said that they could keep the feces at least one week. There is some contrast between the data from the questionnaire and focus group. Data from focus group shows that subjects accepted that they could defecate on their own and other's excretion with the powder. On the other hand, the data from focus group shows that subject did not feel comfortable to defecate even they had the powder. The later reason is similar to the study from Mariwah[7]. Handling excreta is seen as an act of uncleanliness that can pose a health risk. Subjects felt uncomfortable to handle the defecate even though the powder can get rid of the smell and moisture.

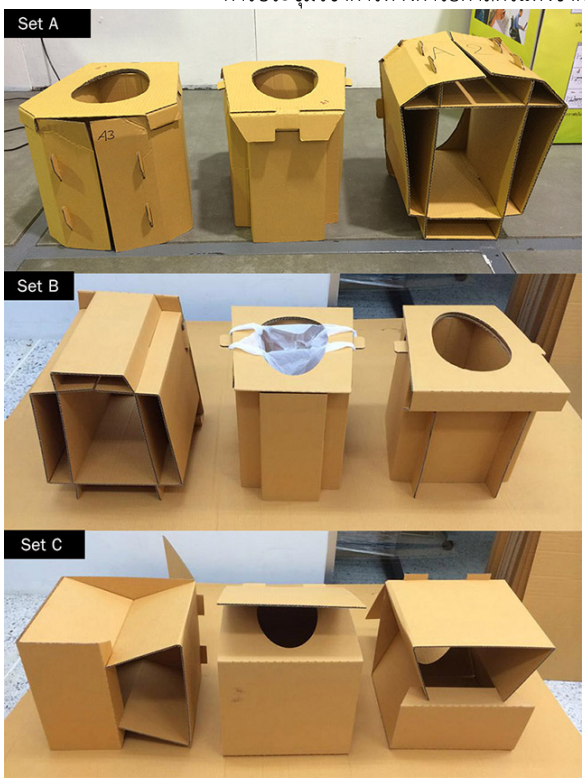

Figure 6 : Three sets of design

Toilet structure may need to be improved in terms of size, comfort and strength. Before doing the focus group, the toilet bowl had been tested with the tensile machine as can be seen in figure 6. Set B was chosen due to the convenience of production and strong structure. Increasing the strength of the product is not difficult, but it must be optimized with the manufacturing production and logistic to the disaster site. Increasing the single wall to double wall adds up the weight of corrugated paper unnecessarily. From the usability testing, the toilet bowl is not difficult to assemble within the time less than 5 minutes. Another way to design the toilet bowl more efficiently is the squatting-type toilet. Cai and You [9] reported an ergonomic approach to public squatting-type toilet design. The 15 degree slop was found to be preferred and safe. Moreover, the height of toilet sitting had been studied with the height of 31-32 cm and 41-42 cm[10]. The result shows that the time spent for the squatting type is lower than other sitting height of 31-32 and 41-42 cm. respectively. Although the squatting type is the best one, several subjects are more than 60 year olds. Aging people have a problem on Osteoarthritis especially on their knees. They are not able to use the squatting type easily.

The paper toilet needs to be waxed since many subjects placed them into the restroom. The structure of corrugated paper may weaken if it is placed closing to the shower area. The bag should not be too long and too big. It should fit the height of toilet bowl. The bag should be

redesigned to separate the urine and discretion. These suggestions are similar to the study of socio-cultural acceptance of the urine diversion toilets in rural Muslim communities [11]. From the focus group, almost all subjects accepted that they needed to separate the urine out of discretion. They modified the way of using the paper toilet by themselves with a urinal bottle.

In conclusion, the toilet bowl serves the primary needs and behavior towards attitude. The further development is to redesign the height of toilet bowl, the bag and the powder. The management of human excreta is crucial in terms of waste collection process and utilization of waste.

REFERENCES

[1] The Asia Foundation[Internet] Asia Foundation c2016 [cited Aug 21, 2013] Thailand Floods[about 1 screen]. Available from http://asiafoundation.org/tag/thailand-floods/

[2] Bailey, A.G., U.S. Patent No.6047414 (1999).

[3] Bigler, J. U.S. Patent No.3097016 (1963).

[4] Wharton, R. U.K. Patent No.GB 2448945A. (2007).

[5] Teeravarunyou, S., Pongsak, K., and Kamonwit, K.. Portable toilet. Thailand Pretty Patent Identifier No.10651. (2557).

[6] Ajzen I., The theory of planned behaviour. Organizational Behaviour and Human Decision Processes, 50, 179-211. (1991)

[7] Mariwah, S., and Drangert, J., Community perceptions of human excreta as fertilizer in peri-urban agriculture in Ghana. Waste Management & Research, 0(00 1-8). SAGE publication (2011). DOI: 10.1177/0734242X10390073.

[8] Esrey, S. et al., Closing the Loop Ecological Sanitation for Food Security. Swedish International Development Cooperation Agency. Mexico. (2001)

[9] Cai, D., and You, M., An ergonomic approach to public squatting-type toilet design, Applied Ergonomics, Vol 29, No. 2. Pp 147-153, 1998.

[10] Sikirov, D. Comparison of straining during defecation in three positions: results and implications for human health, Digestive diseases and sciences, Springer. (2003).

[11] Uddin, SMN., Muhandiki, S V., Sakai, A., Mamun, Al A., Hridi, S M., Socio-cultural acceptance of appropriate technology: Identifying and prioritizing barriers of widespread use of the urine diversion toilets in rural Muslim communities of Bangladesh, Technology in Society. Vol 38, Aug, pp. 32-39 (2014)

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