

ONE SIZE DOES NOT FIT ALL

Implementing technical and social assessments of sanitation reforms in rural Indonesia



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Abstract

The deadline for the Millennium Development Goal (MDG) No. 7, to halve the world's population without access to improved sanitation is fast approaching. Reports have shown that significant progress have been made since its first initiation in the 1990s. Unfortunately, based on the current development rate, the estimated population of the world that will have improved sanitation in 2015 will be 67%, which lags behind the target goal of 75%. Regardless, countries, government agents, sanitation experts and health organizations worldwide are continuously cooperating together to stay on track with the MDG with the objective of improving the health of the world's population and to achieve environmental preservation. In order to provide sanitation facilities that achieves this objective, many different types of decision-making frameworks have been developed to guide decision makers in selecting the most optimal sanitation facility that could function under local conditions. These tools have varying criteria, there are one that focuses on the technical feasibility and other assess the systems based on the incurred cost as well as the willingness to pay of the user. Models that recognizes the sensitivity of the social-cultural influence of the users have also been created. Though, difficulties may come when communities ought to be assessed and expressing findings or social phenomenon in quantified values.

In light of progressive development in the sanitation world, this research aims to participate in implementing a socio-tech assessment on sanitation options in Banten, Indonesia. It has been abundantly seen that sanitation options implemented in the past stopped functioning within a period after its construction. Poor operation and maintenance, lack of managerial oversight and unavailable funds are some of the issues that trigger the abandonment of these monumental sites.

The technical functionality of different sanitation options will be assessed by adopting the decision making tool developed by Malekpour (2012). Furthermore, social assessments using qualitative analysis were conducted using three different case studies to investigate the current practices of the communities and to identify their needs and requirements with the available sanitation options. The three different sanitation systems that have passed the screening stage were 1) pour flushed toilet – communal septic tank – subsurface constructed wetland; 2) pour flush toilet – communal septic tank – upflow filter; and 3) pour flush toilet – biogas digester. After sanitation options were assessed based on a probability evaluation on their performances for the criteria of exposure to health hazard, accessibility, reliability and sustainability, the sanitation option that performed the best was the option that used the pour flush-toilet connected to a communal septic tank and subsurface wetland.

Results from the social assessments showed that receptivity of a technology is greatly influenced on its fulfilment on the demands of the users. Factors found to be of dominant requirements include: maintainability, affordability, water accessibility and convenience. By combining the findings from both the technical and social assessment, this research proposes an open toilet design that have been tailored to the practices of the local users, with a squatting pour flush toilet pan (aiding local users that are classified as *washers*), connected to a communal septic tank and finally to a constructed wetland with subsurface flow. This design aims to attain acceptability from the users, to motivate optimal usage of the facility and achieve health and environmental improvement in the project area of Banten, Indonesia.

Preface

This thesis was conducted as one of the requisites to complete the Sanitary Engineering track of the Watermanagement Master program at the Civil Engineering Faculty of Delft Institute of Technology. This final graduation project was enabled through the joint sanitation project of World Waternet in Teluk Naga in the Banten Province in Indonesia.

I would like to express my deepest gratitude to my graduation committee, Prof. Jules van Lier, Dr. Merle de Kreuk, Dr. Johan Molenbroek and Enna Klaversma. I sincerely appreciate all your time and kind considerations. Thank you very much for the valuable inputs and discussions.

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My appreciation goes to World Waternet for giving me the opportunity to see the 'other' side of rural Indonesia. Being immersed in the various social settings, meeting so many people with different backgrounds, have allowed me to think outside the box. I would like to also thank PERPAMSI Banten, IUWASH (USAID) for generously facilitating my field study and data collection. I'm sorry that I am not able to mention everyone, but *nuhun pisan*.

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1 Introduction

"Diarrhea is one of the top three killer diseases in developing countries, claiming the lives of more than three million children a year. Improvements in water supply and sanitation in the last 20 years have helped to cut the incidence of diarrhea."
(UNICEF, 1999)

As a general rule, it is accepted that improvement in sanitation facility and hygiene behavior help reduce morbidity caused by waterborne diseases (Hoque et al., 1996, Wilson and Chandler, 1993). However, provision of access to better sanitary reform differs from effective use of the reform by the direct users. If provisions are not matched with the needs of the communities, the objective of health (and environmental improvement) is not met.

There are many factors that determine to the outcome of a sanitary reform. The most commonly acknowledge are technical aspects, institutional management and personal (individual) user perception and acceptance. Stakeholders have their own interests, stakes and power in the implementation of a reform. In low-income areas local governments, external actors and donors have large power and influence to promote the implementation of a sanitary reform. However, many have not succeeded because the direct users were not taken into consideration during the planning and decision-making process of the reforms. Although direct users have low influence and interest in a sanitary reform, they have the highest blocking power by potentially neglecting the provided sanitation facility. In order to avoid the unwanted outcome of a top-down approach, many recommendations have been made to increase the community's participation in the decision making process (BAPPENAS, 2010).

Referring to assessments of sanitation options Palaniappan et al. (2008) mentions that "Efforts to address this water supply and sanitation shortfall have shown that no single technological solution, economic tool, or institutional structure can be applied to all populations". Developers and assessors of frameworks have emphasized the integration of the technical, social and economic aspects in a decision-making tool for a sanitation option (Louis and Magpili, 2007; Helmer and Hespanhol, 1997; Ridgley, 1989; Palaniappan et al., 2008; Mara, 1996; van Buuren, 2010; EAWAG SANDEC, 2011; Agudelo et al., 2007). Nevertheless, the diverse range of criteria involved (within the technical, social and economic scope) has limited the creation of an integrated framework. Generally, the available tools generated to select the most suitable sanitation option tend to be focused on certain areas (Malekpour, 2012). Münch and Mayumbelo (2007) evaluates and compares the different sanitation systems based on their total net present value, frameworks such as Open Planning of Sanitation Systems and Sanitation 21 focuses more on the functionality and managerial requirements of sanitation systems (Kvarnström and af Petersens, 2004, Helmer et al., 1997, Evans and Saywell, 2008) uses algorithms that guide the decision makers to a sanitation system that is most suitable with the physical and technical conditions of the local area.

Referring back to the statement of Palaniappan et al. (2008) one cannot simply consider a single aspect (in order) to determine the success of a reform. When putting forward only one aspect and ignoring the rest, it is not uncommon to have abandoned projects. This is abundantly seem in Indonesia whereby the constructions of the *MCK* facilities; *mandi*, *cuci*, *kakus* (bathing, washing, and defecating), are referred instead as *Monumen Cipta Karya* (BAPPENAS, 2010). This terminology is used to represent *MCK* facilities that serve as untouched monuments constructed by the Ministry of Public Works. Often such failures are attributed to the fact that a the needs of the users were not taken into consideration and standard (conventional) designs are being replicated without considering the specific characteristics of the project area. Sanitation reforms should be thoroughly assessed from the techno-socio-economic aspects so that the appropriate system performs appropriately and meet the objectives of improving the health of the community and the environment.

1.1 Hypothesis

The main hypothesis of this research is that conventional sanitation reforms do not fit the need of the local users.

1.2 Objective

The objective of the research is to prove the hypothesis by answering the following research questions:

- 1) What are the current habits of the users?
- 2) What are the needs/requirements of the users?
- 3) How should the design of the sanitation facility be adjusted in order to meet the needs/requirements of the local users?

1.3 Reader's guidance

The following chapter introduces the methods used in this study. In the technical assessment the works of Malekpour (2012) has been adopted and for the social assessment, qualitative analysis will be used. Further explanation on the different sites namely the pilot project area in the Banten Province and the sites of the case study in the West Java Province. The step-by-step technical assessment will be performed in Chapter 3, and the social assessment depicting the findings of the case studies will be discussed in Chapter 4. The evaluation of both assessments (technical and social) will be delivered in Chapter 5 with a concluding sanitation design proposed from the findings gathered in the technical and social aspect. Lastly conclusions and recommendations on conducting sanitation system assessments will be provided in Chapter 6.

2 Methodology

This report intends to approach the assessments sanitation reforms through both the technical and the social aspects. The following subchapters aim to describe the methods used during the undertaking of this final thesis project. The methodologies discussed would be referring to 1) the application of the technical framework in assessing sanitation reforms (Malekpour, 2012), 2) the social assessments of the sanitation reforms in West Java to investigate the current habits and the needs and requirements from the users in a sanitation reform.

2.1 Technical assessment

The technical assessment deals with the adoption of the decision making framework created by Malekpour (2012). There are two phases involved in implementing the framework. Firstly, various sanitation options (flushed toilets, dry latrines, bio-latrines, ecosans facilities, centralized facilities) are screened, whereby it needs to fulfill a basic requirement for its functionality in the given site. The functionality of the sanitation systems is assessed based on its suitability with the local conditions. Failure to comply with these requisites will result in elimination of the sanitation option. As shown in Figure 1, the remaining systems that passed the first screening process will be entered into a probabilistic evaluation that are based on exposure to health hazards, accessibility, reliability and sustainability (Malekpour, 2012).

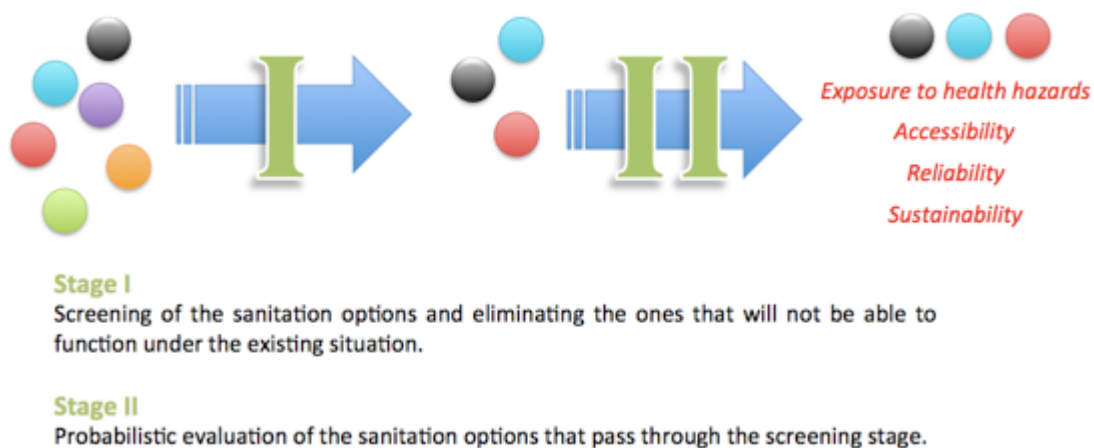


Figure 1 - The flowchart of the decision making tool for assessing sanitation options (Malekpour, 2012)

The list of (field) data that are necessary in order to implement the framework is presented in Table 1 of Appendix 1. Due to the limited time and resources of the field study, not all the required data were gathered.

Data were collected from the field (observation) as well as from secondary sources, including the preliminary survey conducted by IUWASH in April 2012 whereby respondents from 52 households were interviewed to gather in a baseline survey on the water supply and sanitation condition of the area. Other sources included the Bureau of Statistics of Kabupaten Tangerang (BPS Tangerang), the Kabupaten Tangerang Environmental Management Agency (BPLHD), personal correspondence with experts and operators in the water supply and sanitation sectors.

2.2 Social assessment

In assessing the social aspect of the demand-based technologies, this research investigates additional two sanitary reforms in low-income areas of two opposing nature that have been constructed and operated. One of the selected reforms will be a functioning facility that is still being used by the local communities, whilst the other site will be a facility with low effective usage by the local communities. These sites were selected based on the allowable scope and resources within the limited time of this research. A recommendation has been to select reforms that originate from comparable cultural background areas within the West Java Province. The main purpose of such approach is to eliminate heterogeneous characteristics of the users (due to differing cultural background) that may influence the outcome of the reform. Qualitative analysis would be used in this assessment using participative evaluation and the triangulation method, whereby 1) Focus Group Discussion (FGD), 2) Interviews, and 3) On-spot observation will be used to validate the findings. Qualitative analysis was chosen primarily for the objective of this research, which is to investigate the current habits of the users and their requirements concerning a sanitation reform. The flexibility of the qualitative research allows room for the researcher to adapt methods that are appropriate for the given situation (Onwuegbuzie and Leech, 2005, Firestone, 1987, Farmer et al., 2006). The triangulation method originated from the navigation and military strategy that used multiple reference points to locate the exact position of an object (Jick, 1979). Similarly, triangulation is often used in qualitative research to validate the narrative of the researcher that have used different sources in explaining a particular phenomenon (Creswell et al., 2003, Flick, 1992, Johnson and Onwuegbuzie, 2004).

2.2.1 Participants and design

The two sites that have been selected originally were located in the West Java Province. These sites were chosen based on the recommendation of the field officers of IUWASH and the local authority of the Bogor City. Due to the nature of the recorded interviews that were taken without the consent of the interviewee, the names of the locations will remain classified. Site A and Site B have had sanitary reforms built and operated in the area, 2010 and 2009 respectively. They are of two opposing nature, a successful reform and a failed reform, according to the evaluation of the field officers from the City of Bogor. Both of the areas have similar design of a biogas digester coupled with a latrine and a washing area at the top of it, with connecting pipes for the effluent several households within the community. Such facility is commonly known as the washing-bathing-defecating facility (MCK). Brief descriptions of each site can be found in the following section.

Site A

Among the dozen of sanitary reform constructed in the City of Bogor, Site A was seen as the least successful of all (Source local authority, September 2012). Constructed in 2010, the sanitation infrastructure is connected an on-site MCK having two latrines each in its own cubicle (See Figure 2), with 30 households wastewater connections. It is located in high-grounds between the Cisadane and the Cikapancilan river (See Figure 3).

Living in such area, have prevented the locals from abstracting groundwater, hence you will find that most of the locals are connected to the in house water line from the regional water company (PDAM Kota Bogor). According to one of the local leaders, it was by request of the people within the communities to improve their sanitation infrastructure. Nevertheless, prior to the completion of the facility, the person in-charge of socializing the information (operation/maintenance) to the locals was requested to immediately take on another position in a different place. This had disconnected the chain of information, and have since then led to the neglect of the sanitation facility. Locals are used to heading to a simpler washing facility down by the river, which utilizes groundwater at no extra cost.



Figure 2 - The MCK of Site A



Figure 3 - Site A

Site B

Entering Site B, one could only wonder how the materials were brought in to construct the buildings. As seen in Figure C this village is located away from the main road with paths that would only allow motorcycles to pass through. Needless to say, the washing – defecating facility of Site B outcompetes that belonging to Site A. It was clean, tidy and you see several locals regularly visit the facility and do their washing (See Figure D). This was largely due to the upkeep efforts of the head village and his deputy. They have been responsible for maintaining and cleaning the facility. Additionally, they have delegated another member of the community to arrange the monthly usage fee of using the sanitation facility. The Biogas Digester in Site B was constructed in 2009. However, the recommendation of its successful reform did not come with a functioning system. In fact, the biogas digester had not been operated since it was operated. Furthermore, the digester that contained over 40 household connections have not been de-sludge since its construction. Financial issues have hindered the process, according to the constructor of the facility (Informant BEST, September 2012).



Figure 4 - Site B



Figure 5 - MCK of Site B

Site C

Right across Site B, the locals of Site C have benefited greatly from the construction of the washing-defecating facility. The two areas are separated by a small stream. Several households have asked for the permission from the village leader, and have since joined the monthly collection. Although they are not prevented from using the facility, subtle tensions have risen as locals of Site C commute and utilize the facility in Site B.

2.2.2 Procedure and measures

Focus Group Discussion (FGD) has been selected as one of the triangulation qualitative analysis method along with in depth interviews and literature/secondary review. One of the purposes of FGD is to accommodate a discussion forum that will help the locals communicate their (main) concerns in their community. Focus Group Discussions is an excellent method to 'get to the bottom of the subject' (UNICEF, 199). Set at duration of up to 60 minutes, the session allows in depth discussions that are within the scope of the research

(Garnett, 2013, Okot-Okumu and Oosterveer, 2010, Von Knorring et al., 2008, Xu et al., 2004). The limited time allocated for the session has been adopted to allow high affectivity of the discussion forum, whereby the participants were focused entirely. A longer period for the discussion session would not be effective, as many respondents would have surpassed their attention time (Rubin and Rubin, 2011). The members that have been selected to participate in the FGD were women, as they were the ones closely related to the health and sanitation issues of the area. In addition, the men were rarely seen during the field visits (day time) as they are working day-shifts. The women in the FGD were all wives with children. There were 6 participants in the FGD in Site A and the women were within the age of 20 – 30 years old. Half of the participants did not work, two were working part time (morning-shift) as domestic helpers and one of the participants owned a food stall at the village. In Site B there were 4 women within the age of 25 - 45 years old and all of them were not working.

The bathing-washing-defecating (MCK) facility is used by communities. During the FGD, participating users were separated from different districts. This was done to encourage locals to communicate more freely and express their true concerns (*without holding back*) (Jetten et al., 2002). Furthermore, a varying level of users were gathered. One of the drawbacks of FGD is the possibility of users being influenced by over opinionated participants (Kitzinger, 1994, Morgan, 1996, Powell and Single, 1996). Fortunately, the varying perceptions of users provided an environment that was conducive to trigger discussion. Users with disagreeing opinions regarding the facility were able to express their reasons and simultaneously attain perceptions that were on the contrary to theirs.

Participative Evaluation was conducted during the Focus Group Discussion. It provided the chance for users to assess the available sanitation reform from their own perspective. The methodology from Narayan (1994) was adopted, whereby statements regarding health, hygiene and sanitation issues were asked to the participants. Users were then required to rate the statements based on whether or not they agree to the statement. A score of 1 represents strong disagreement, 2 for disagreement, 3 for not knowing, 4 for agreement and 5 for strong agreement. Users discretely expressed their concerns in a piece of paper that were then collected at the end. Answers were then revealed and placed accordingly on a numbered scale and the group discusses on the general score or rating which represents the community. The data produced through this method was not included in this study as it was found that users had did not give the same score as the real situation.

Spot observation

Semi-structured interview have no rigid set of questions (Ritchie and Lewis, 2003). Researchers have in mind of important aspects they would like to investigate, however the means of attaining the answer varies as it flows with the discussion with the respondent. It relies on the interviewer's ability to keep the respondents at ease and converse naturally as well as being aware on pursuing lead points in the course of the interview (Drever, 1995, Wengraf, 2001). During the field study in both Site A and Site B, semi-structured interviews were used at the preliminary stage and building up to the FGD with the community. The topic of discussions were prepared prior to the visit. After departing from Site A and Site B the findings were gathered on field notes. There were no questionnaires used, as it proved to limit the extent which the respondents would like to share their stories. During the semi-structure interview, the snowball effect was also applied, whereby other community members to be interviewed were based on the recommendation of the previous respondent (Myers and Newman, 2007, Noy, 2008, Polkinghorne, 2005). The snow-balling strategy also aided in gathering participants for the FGD.

Spot Observation is highly recommended in completing the triangulation method as it allows researchers to validate responses attained from other methods. Researchers could visit and walk around the neighborhood by taking (mental) notes on particular practices of the local community. Structured observation can also be done whereby the researcher asks the permission of the locals to enter their households and remain there as an observer on a regular basis (e.g. in the morning between 06.00 – 09.00am) (Curtis et al., 1993, Stanton and Clemens, 1987). The members of the household should be asked to ignore the observer and continue with their activities as normal as possible. When observing the defecation practices and the

sanitation condition of an area, it has been suggested that the researcher informs the visited household that the main focus is children's health of women's work (UNICEF, 1999). The effect of an altered behavior of the household members (influenced by the presence of an observer) should also be noted and taken into consideration during the assessment. In this field study, structured observations were not conducted in the households of the local communities, instead spot observations were done during the day as the researcher visits different gathering spots of the women such as food stalls and junctions.

2.3 Site description: Teluk Naga

2.3.1 Location and area

Kecamatan Teluk Naga is part of Kabupaten Tangerang in the Banten Province, with the following coordinates : 106°37'39" – 106°43'06" Bujur Timur and 6°00'24" - 6°06'24" Lintang Selatan. The northern part of Teluk Naga borders the Java Sea and the *Kabupaten Kepulauan Seribu*, DKI Jakarta Province. In the East it borders Kecamatan Kosambi. In the West it borders Kecamatan Sepatan and Kecamatan Pakuhaji, whereas in the South it borders the International Airport of Soekarno Hatta in the City of Tangerang. The total area is 5330 ha (BPS Tangerang, 2010), consisting of 13 villages and a land elevation of 2-3 meters above sea level with a gradient of less than 5% and predominantly silty sand at the top soil (Dinas Lingkungan Hidup, 2004 and Sunandar, 2009). The study conducted by Sunandar (2009) revealed that the majority land usage of Kecamatan Teluk Naga is wetland (rice-fields) for harvesting (44,5%), whilst the residential area is only 20,3%. The climate of Teluk Naga follows the Indonesian climate, consisting of a rainy season and a dry season each year. The historical data collected by the BPS Tangerang over two decades shows that the dry season occurs between June – October.

2.3.2 Population

The total population of Teluk Naga is 138288 people and the density is 26 ca/ha. The villages and their populations can be seen in the Appendix. The highest composer of the population are the age groups between 15 – 24 year olds (22%) and 2.8% of the population are older than 65 years old. Additional inventory from the Health Center of Teluk Naga (2010) recorded that 1472 elderly above 70 years old lived in Kecamatan Teluk Naga. This exceeds the national life expectancy of 69 years old in Indonesia (BPS Indonesia, 2010). This comes close to The population density of each village is presented in Figure 6 as adopted from the statistics of BPS Tangerang (2010). The number one illness that is prevalent in Kecamatan Teluk Naga is the upper respiratory tract infection with 7,2% of the total reported illnesses in the Teluk Naga Health Center in 2011. Whereas, waterborne diseases such as dermatitis and diarrhea consisted 2,2% and 0,9% respectively of the total reported illness recorded by the Teluk Naga Health Center in 2011. In comparison with Indonesia, this number is relatively low as the average clinical prevalence of diarrhea is 9% with diarrhea in the 6th place in the top 10 leading causes of morbidity in Indonesia (Depkes, 2011, Adisasmito, 2010).

From Figure 6 it can be seen that Kampung Melayu Timur and Kampung Melayu Barat were the two villages with the highest population density. Kampung Melayu Timur has an area of 209,5 ha with a total population of 18792 resulting in a density of 89,7 ca/ha and Kampung Melayu Barat has a total population of 11305 in an area of 111,7 ha, hence the population density of the village is 101,2 ca/ha. These two villages are the central government activities of Kecamatan Teluk Naga with the presence of health centers, residential areas, markets and schools (Sunandar, 2009). Both Kampung Melayu Timur and Kampung Melayu Barat had been selected by IUWASH (USAID) as the potential sites to conduct sanitary reform based on the request of the local authorities. Kampung Melayu Timur RT 01 RW 01, the selected area of study in this research will be further discussed in the following sections based on the data collected from field observations in May 2012 and secondary sources from the Baseline Survey

of IUWASH (USAID) conducted in April 2012. The survey consisted of 52 households performed by two facilitators from the Health Centers that had been trained previously.

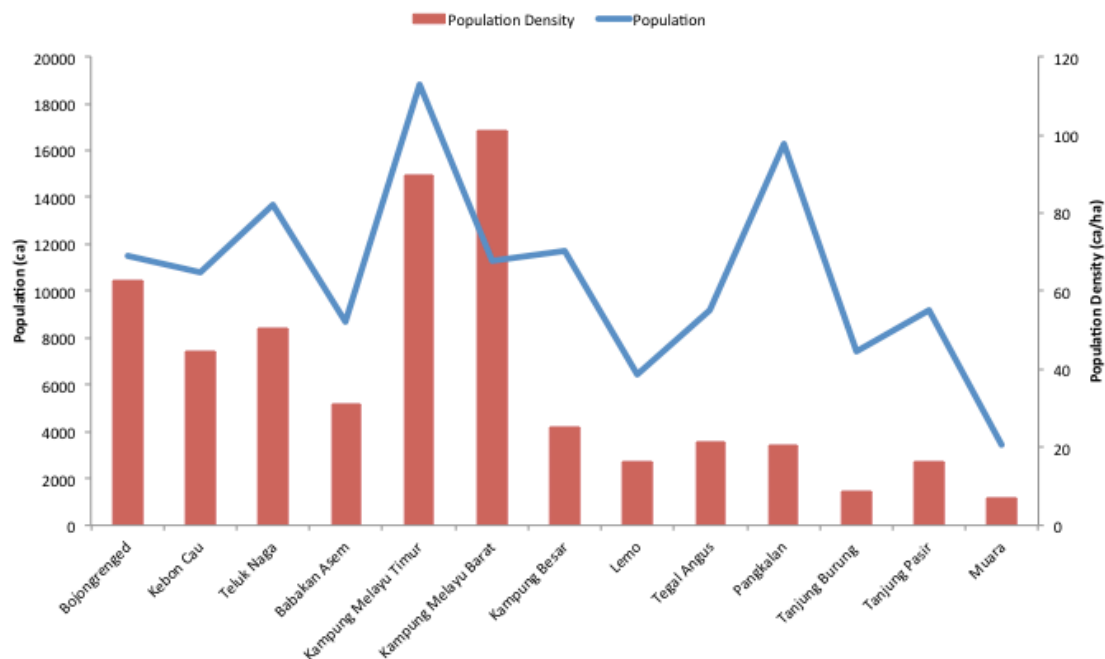


Figure 6 - Population and population density of Teluk Naga (BPS Tangerang, 2010)

2.3.3 Pilot project area: Kampung Melayu Timur RT 01 RW 01

Kampung Melayu Timur RT 01 RW 01 is located away from the main road and the irrigation canal. The residential area is surrounded by wetland (rice fields) as shown in Figure 7 (adopted from IUWASH, May 2012). The total number of residents living in the 52 households in the area is 260. On average there are 5 people per household and there were two households having more than 10 people per household. The house area ranges from 30-250 m² resulting in an average of 15 m² of inhabiting area per person with an average daily water usage of 100 L/d/ca.



Figure 7 - Project area Kampung Melayu Timur RT 01/RW 01 (IUWASH, 2012)

2.3.4 Clean water and drinking water sources

The community of Kampung Melayu Timur RT 01 RW 01 are heavily dependent on clean water sources from the well. 88% of the residents rely on hand dug wells and 6% relying on deep well. Figure 8 shows an example of an indoor hand dug wells in one of the households. Presently only 6% of the community members are connected to the water service line of the local water utility company (PDAM). The hand dug wells are quite shallow, with depths ranging from 1 – 2,6 m.



Figure 8 - Washing area inside a household with hand-dug well

For the source of drinking water, the locals rely 5 different sources (see Figure 9). The highest consumed source is the opened water galloon refills (40%). These refills are obtained from the street stalls and locals can bring in empty galloons or ask for it to be delivered to their home. The next most consumed water is the well water (33%), followed by the water from the mobile vendors with the crate that walks around the village (15%), from the water service line of PDAM (10%), and lastly the sealed water refilled gallons are consumed the least (2%) by the community.

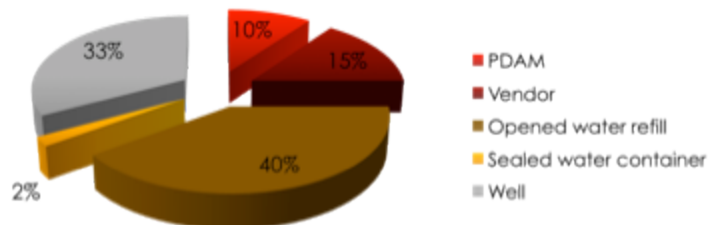
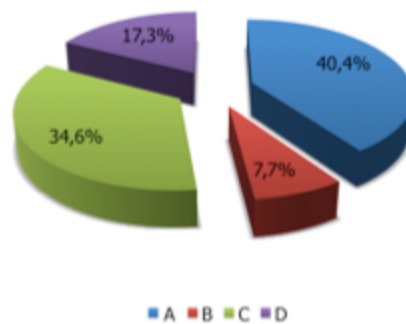


Figure 9 - The drinking water sources in Kampung Melayu Timur RT 01/RW 01

Based on the personal communications with the locals, some have alternate between the drinking water sources (e.g. from using well water to using refilled water gallons or vice versa) due to the preference of their family's taste. The water from the PDAM service line, the mobile vendor and the well are previously boiled prior to consumption. The water quality from the different sources can be referred in Table 2 of Appendix 1 (PDAM TKR Laboratory, 2012).

2.3.5 Defecation practices

During the survey locals were asked about the sanitation facilities that are accessible to them. The findings showed that there were no washing – bathing – defecating (MCK) facility in the area, hence users either owned their own washing and toilet facility, shared with the neighbor or relieve themselves outside. Figure 10 shows the recapitulation. As seen below almost 35% of the community admitted to open defecation. Nevertheless, when compared with only 40% of the community that owns a septic tank (connected to their facilities), it should be re-investigated where the community of D (claiming of owning only a washroom at home) relieves themselves, and whether or not they too practice open defecation similar to C (admits defecating openly in the fields).



A: claims of owning a washroom and a toilet at home
 B: claims to share the toilet owned by the neighbors
 C: admits to open defecation in the fields
 D: claims of owning only a washroom at home

Figure 10 - Defecation practices and sanitation facilities owned by the locals of Kampung Melayu Timur RT 01/RW 01

The issue of toilet (backdoor business) and the process of relieving oneself is commonly not a preferred topic of discussion (Ross, 2010) owing to the (private/unsanitary topic that it is perceived as (Larrousse et al., 2006). Fortunately, (after being more acquainted with the community) it was easier to attain information regarding the locals' habits in open defecation.

The exact number of people in the community that practices open defecation could not be determined. Nevertheless, conversations with the local women during gatherings revealed that open defecation was in fact commonly practiced by the majority of the community. For the households that own a sanitation facility at home, it was found that the reasons for constructing private (indoor) toilets are due to (physical) limitations which prohibits them to defecate out in the open such as old age and the condition of being pregnant. In addition, there were also spouses that originated from out of the village that requested the construction of the private toilets at home to fulfill the demands of their previous habits.

One of the most interesting findings was the fact that one of the household owns a private toilet at home (See Figure 11) but does not use the facility, as it was purposely built for outsiders or guests from out of town. The only person that uses the facility at the house is the son who had worked outside.



Figure 11 - Indoor washroom and toilet facility (used by 1 member of the household) in Kampung Melayu Timur RT 01/RW 01

This phenomenon resembles the trial-adoption phase that could result in positive behavior formed towards the facility (seen in the behavior of the son) or a negative attitude towards the facility (seen by the woman and the remaining of the family) (Rogers, 1995). The trial adoption period is essential for the adopters to form a positive or a negative attitude toward the installation (Rogers, 1995, Nakicenovic, 1991). The son had seen the benefits of having the standard toilet (KEPMENKES 519/2008), which provided privacy, water accessibility, and convenience (at home not outside); whilst the remaining of the family felt that the enclosed

construction of the toilet give a sense of claustrophobic, hence making the process of relieving oneself uncomfortable and somewhat hindered (Personal Communication, May 2012).

2.3.6 Wastewater estimation

According to the baseline survey conducted by IUWASH in 2012, the average daily clean water consumption is 0,49 m³/hh and 0,10 m³/ca. The total daily consumption of clean water is 25,59 m³/d. There are 260 residents in RT 01 RW 01 with an average of 5 people per household. There is a wide gap between the minimum and maximum number of people in a single household, 1 ca/hh and 11 ca/hh respectively. The large number of people under a single household is attributed to the fact that extended families also live under the same roof (under one roof).

In general, the wastewater production is considered to be 80% of the clean water consumption (Mara, 2003), ergo the average daily wastewater productions are 0,39 m³/hh.day and 0,08 m³/ca.day. The total produced wastewater in the pilot project area is estimated to be 20,47 m³/day.

2.3.7 The influence of introducing in-house water supply

Currently, the majority of the local communities are relying on shallow (hand-dug) wells, with 46 % and 42 % using private and communal wells respectively (See Figure 12). Clean water abstracted from these wells is obtained for free. The locals merely had to invest on a capital fee for its construction and they have unlimited water supply (depending on its availability). It was also found that these water sources had seasonal variability. Wells are recharged at a slower rate during the dry season, and it is not uncommon that several wells in the vicinity run dry.

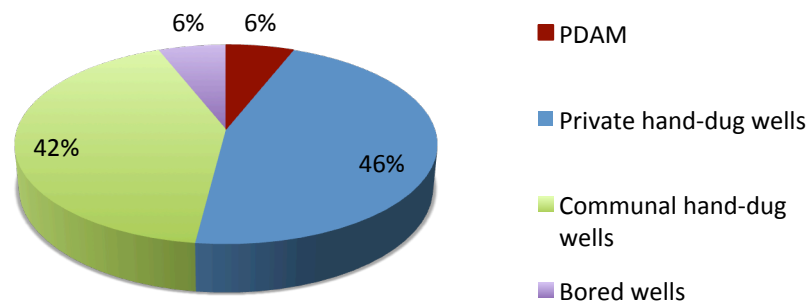


Figure 12 - Clean water sources in Kampung Melayu Timur RT 01/RW 01

As previously mentioned, the objective of the pilot project is a program to improve both the clean water supply coupled with enhancing the sanitation condition of the project area. It is then recommended to consider the effect of introducing in house water taps into the communities. Assuming continuous distribution from the water supply utility company (PDAM), the locals will gain access to continuous clean water supply. Nevertheless, there have been incidences in the past when water distribution to the consumers were temporarily disturbed due to the fact that surface water sources delegated as point of abstraction for the clean water treatment has exceptionally low water levels during the dry period (PERPAMSI Banten, 2012).

As seen in Figure 1, 6% of the households in RT 01 RW 01 are already connected to the water service line of the PDAM. The daily water usage of the area is presented in Figure 13, whereby users that are connected to the PDAM service water line is indicated with the red bars, and the remaining users that rely on the well water are presented with the blue bars. It can be seen

from Figure 13 that two out of the three households have lower water consumption; 0,05 and 0,07 m³/ca.d compared to the average daily water consumption of the community, 0,1 m³/ca.d (presented with the dashed line). On the other hand, the remaining 1 household has very high water consumption of 0,64 m³/ca.d.

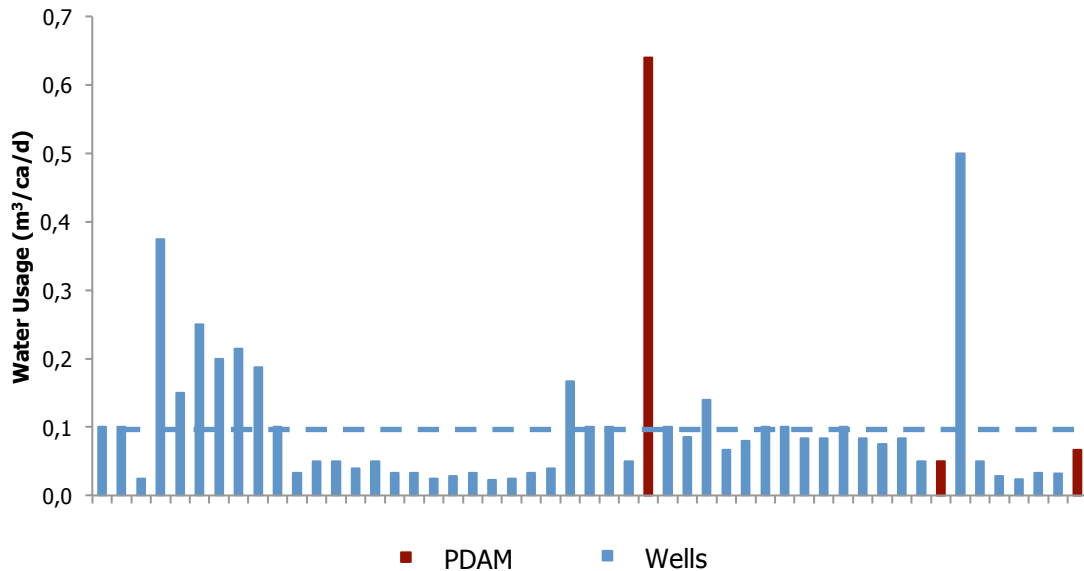


Figure 13 - Daily clean water usage in Kampung Melayu Timur RT 01/RW 01

The lower - less than average, water consumption by the households connected to the PDAM water service line corresponds to similar patterns seen in other sites. Comparable water usage pattern was reported from several areas across West Java, which relied on water retribution fee to control clean water consumption. In Cibodas, progressive water charge has been implemented that have proven to hold back habits of excessive use of water (Mungkasa, 2008). The fact that there is a water retribution fee for users connected to the PDAM water service line has made the users less consumptive and became more careful in using their clean water source. The water fee has become a penalty and means of controlling clean water usage (Mungkasa, 2008).

Nevertheless, by analyzing Figure 13 one of the households that is connected to the PDAM service line has a higher water consumption of 0,64 m³/ca.d, which is more over six times the average water usage in the area. This may be due to the fact that combined water sources from both the service line and the private well are used at the household level. Similarly, Site A of the case study in the West Java Province, whereby the community members are already connected to the service line of the PDAM; are utilizing the tap water for limited usage (for the kitchen) and still rely on groundwater abstraction in a communal source. Mungkasa (2008) also mentions that water pricing played a major role in limiting (large) water consumptions of its users.

The expected pattern to emerge as soon as clean water service line is connected to household level is that the daily water consumption, hence the wastewater production, will increase. Notably, the water consumption pattern that could become apparent within households will be:

- Complete reliance on clean water from the PDAM service line or,
- Both the existing wells and the in house water connection will be used interchangeably to meet different needs.

Both the aforementioned patterns would result in water consumption, which is similar with the existing situation. The former type of water usage would lead to an equal or (even a lesser)

water usage compared to the present situation, whereas the latter would lead to equal (or higher) water usage vis-à-vis the current situation.

In this report the future water consumption will be assumed to remain the same as the present state of 100 l/ca.d with a wastewater production of 80 l/ca.d.

2.3.8 Blackwater and flushed water

As explained previously, the assumed wastewater production in the future would remain similar with the present situation of 80 l/ca.d. The general breakdown of the daily water consumption can be seen below in Table 1.

Table 1 - Domestic clean water usage

Activity	Volume of water	Reference
Washing	10 l	Mara (1991)
Bathing	10 – 20 l	Mara (1991)
	25 l	Field observation
Flushing water	1.5 – 5 l	Mara (1991)
Urinating	2 l	Field observation
Defecating	4 l	Field observation
Excrement + flush water	5 – 10 l	Mara (1991)
Anal Cleansing	5 – 10 l	Mara (1991)
Cleansing after urination	2 l	Field observation
Cleansing after defecation	4 l	Field observation

All of the water usage mentioned in Table 1 are conducted in the majority of the project area, apart from the water flushing for toilets. The majority of the locals are accustomed to practice open defecation, which do not involve flushing (with water) of the excrement disposed in the environment. On a regular basis, the locals bathe, wash clothes/dishes, and perform anal cleansing at their homes.

Assuming that a single person urinates three times a day and defecates once a day, then, the additional wastewater from flushing is 10 l/ca.d. Therefore, the average daily wastewater production is estimated to be 90 l/ca.d.

Based on Table 2, the computed wastewater produced from a unit by each person in a single day (assuming the person urinates three times and defecates once a day) is 20 l/ca.d.

Table 2 - Water usage for flushing and cleansing after excreting

	Activity	Volume required	Frequency (d ⁻¹)	Total volume of water
Urination	Flushing	2 l	3	6 l
	Cleansing	2 l	3	6 l
Defecation	Flushing	4 l	1	4 l
	Cleansing	4 l	1	4 l
TOTAL				20 l

2.3.9 The projected wastewater production

According to the Bureau of Statistics (BPS) of Kabupaten Tangerang in 2011, the average growth rate of the population in the district of Teluk Naga is 3.19%. The existing population is 260 people. By computing the above information the predicted population in 20 years will be 488 people. This will lead to a total blackwater production of 9.8 m³/day.

3 Implementation of Framework on Teluk Naga Pilot Project

It is important to have the appropriate selection for a sanitation option in an area. In this chapter, the focus of the selection will be based on the on-site technical feasibility.

3.1 Screening

In contrary to most decision-support tool, the following screening procedure was not designed to derive the most suitable sanitation option, but instead it was designed by Malekpour (2012) to eliminate "non-implementable" options. The requirements that will be observed in this preliminary screening stage are water supply availability, soil type, groundwater table, possibility of infiltration and space availability. In addition biogas demands, and the presence of a managing and monitoring institutions are also observed for the specific uses of, bio-latrines and centralized facilities.

In order to eliminate conflict, similar sanitation alternatives will be provided to all the target adopters; either shared toilets or private toilets will be offered to the community. It had been explicitly expressed by several locals that communal or shared toilets would not be useful. Locals are reluctant to use shared toilet facilities perceiving that it would be challenging to maintain the cleanliness with many users. This concern is recognized globally as shared latrines are considered as unimproved sanitation facility based on the criteria used to achieve the Millennium Development Goal No. 7 (UNICEF, 2012). Nevertheless, this issue can be resolved by appointing a caretaker or a larger managing body that monitors the operation and maintenance (O&M) of the communal facilities. A retribution fee, which has been discussed and agreed upon by local members, can be used to help finance the O&M costs. Field studies in the provinces of DKI Jakarta and West Java have shown that target adopters are more inclined to pay monthly retribution fee charged per household rather than per usage (Mungkasa, 2008).

Given that more than half of the households in RT 01/RW 01 of Kampung Melayu Timur do not have toilet facilities and 35% explicitly admits practicing open defecation, proposing to improve the sanitation facilities of the area would require dramatic behavior change for the target adopters. It should be carefully considered that the recommended sanitation options should be low-tech, low-cost (capital investment and O&M), with high reliability and performance that fulfills the objective of producing good quality effluents (Brissaud, 2007, Mara and Johnson, 2007). At this point, any proposed sanitation technology, even at the lowest O&M cost, will be competing against the comforts of open defecation. Replacing something free with a fee would be a challenging task that should not be further complicated with complex operating procedures that demand a lot of effort. The selected alternatives of the sanitation options (including the entire sanitation chain) are extensive systems that imitate naturally occurring processes in soils and water bodies (Brissaud, 2007); hence limiting mechanical power and energy input to the operation of the system. A summary of different technologies that fall into the criteria of low-tech sanitation options (Mara, 2007, Mara, 2003, Crites and Tchobanoglous, 1998) that are available to be used in the screening phase is presented in Table 3.

Table 3 - Recapitulation of low-tech sanitation options for rural areas (Mara, 2007; Mara, 2003; Crites and Tchobanoglous, 1998)

Sanitation Option	Description
"EcoSan" toilet	Toilet for the safe reuse of excreta-borne nutrients either with or without urine separation (if separated, urine is collected and stored in a tank for 6 months in container or tank); and with externally accessible alternating twin vaults for dehydrating or composting faeces, paper and organic wastes (possibly with sieves or nets for separating water used for anal cleansing from the faeces). Stored urine applied to garden/field; composted

	faeces and organic wastes used as soil conditioner; and grey water applied in garden/field with or without prior treatment. For EcoSan toilets without urine diversion anaerobic treatment of black water for biogas production and use, and garden/field application of digested sludge.
Biogas digester	Household-level anaerobic digesters treating black water, often with animal excreta and/or household organic wastes. The biogas produced is used for in-house cooking and/or lighting.
ArborLoo	A simple moveable wooden cover slab and superstructure unit placed over a shallow pit. When the pit is full the ArborLoo is positioned over a second pit and a tree planted in the first pit, and so on.
VIP latrine	An otherwise unimproved pit latrine fitted with a concrete cover slab (called a "sanitation platform" or "SanPlat"). A pit latrine with the pit and the superstructure slightly offset to permit the installation of an external vertical vent pipe fitted at its top with a fly screen. The vent pipe exhausts faecal odours and the screen minimizes fly breeding.
Pour-flush toilet	A manually flushed water-seal toilet discharging into an adjacent leach pit.
Septic Tank System	A large watertight tank, commonly with two compartments, which receives domestic wastewater (or only black water) for solids settlement and anaerobic digestion of the settled sludge. Effluent disposal is in soil infiltration trenches or infiltration pits; alternatively in periurban areas, settled sewerage (see below) may be used.
Stabilization Pond	A large shallow basin enclosed by earth embankments in which raw wastewater is treated by entirely natural processes involving both algae and bacteria. Three different types of ponds are: anaerobic pond, facultative pond and maturation pond. The former two are designed for BOD removal whilst the latter is designed for faecal bacteria removal.
Constructed Wetland	Engineer-made (long-narrow-shallow reactors) equivalent of natural wetlands that are designed to reproduce and intensify the wastewater treatment processes that occur in natural wetlands.
Settled Sewerage	A sewer system receiving the solids-free effluent from a septic tank serving a single households or a group of neighbouring households. As the sewer does not convey settleable solids, its hydraulic design is fundamentally different from that used for conventional and simplified sewerage. Secondary wastewater treatment and effluent reuse in aquaculture and/or agriculture or local horticulture.
Simplified Sewerage	A sewer system receiving unsettled domestic wastewaters. Sewer design is based on the same hydraulic principles as those used for the design of conventional sewers, but without any of the very conservative rules-of thumb and safety factors used for the latter. Simplified sewerage uses a minimum sewer diameter of 100mm and self-cleaning of the sewers is ensured by using a minimum peak flow of 1.5 l/s and a minimum tractive tension of 1 kN/m ² (1/4 1 Pa). This results in minimum sewer gradients that are shallow but satisfactory.

One of the main objectives of providing sanitation systems is to allow safe disposal (and treatment) of wastewater to protect human health and the environment (Kvarnström and af Petersens, 2004, Louis and Magpili, 2007, UNICEF, 2012). In order to achieve this objective, (entire) sanitation chains of different treatment systems should be considered before entering the screening phase. Options 4 – 12 in Table 4 are options for sanitation chains using pour flush toilet at the user interface. These will also be included in the screening phase of the sanitation options assessment for the pilot project in RT 01/RW 01 Kampung Melayu Timur.

Table 4 - The sanitation options for Kampung Melayu Timur RT 01/RW 01

No	Sanitation System
1	EcoSan toilet
2	VIP latrine
3	Arbor Loo
4	pour flush – soil infiltration
5	pour flush – settled sewerage – constructed wetland

6	pour flush – communal septic tank – constructed wetland
7	pour flush – simplified sewerage – communal septic tank – drain field trenches (soakaways)
8	pour flush – communal septic tank – drain field trenches (soakaways)
9	pour flush – simplified sewerage – communal septic tank – upflow filter
10	pour flush – communal septic tank – upflow filter
11	pour flush – simplified sewerage – biogas digester
12	pour flush – biogas digester

The aforementioned options will be screened using the algorithm designed by Malekpour (2012) based on existing local conditions and future plans for the implemented sanitation facility in the project area. Nevertheless, several modifications have been made to the original algorithm of Malekpour (2012), based on the inclusion of the socio-cultural aspects as observed in the project area (i.e. the defecation practices by the local community). In this study the following aspects have been considered in the screening phase:

- 1) Methods of anal cleansing
- 2) Water supply availability
- 3) Soil characteristics
- 4) Available space
- 4) Wastewater conveyance using gravity sewerage
- 5) Presence of a managing institution

This modified version of the screening phase aims to eliminate sanitation options that would not be able to function under the technical and socio-cultural conditions in Kampung Melayu Timur RT 01/RW 01.

3.1.1 Methods of anal cleansing

Based on the local customs of the target adopters in Kampung Melayu Timur (Teluk Naga), only wet sanitation facilities will be selected in the first step (See Figure 14). It is a habit to wash oneself after urinating or defecating, indicating that target adopters are classified as 'washers' (Frias, 2008, Mara, 1996). Hence, dry facilities; Options 1, 2 and 3, are not recommended to be installed and will not be included in the screening process.



Figure 14 - Step 1 of the screening phase

3.1.2 Water supply availability

The next step is to screen the sanitation options based on the availability of the water supply. As mentioned previously, target adopters falls under the classification of 'washers', hence the presence of water supply in the planned sanitation facility is eminent. In the joint - cooperation

of the sanitation pilot project in Teluk Naga (World Waternet, PERPAMSI Banten and IUWASH USAID), the regional water utility company of Tirta Kerta Raharja (PDAM TKR) of Kabupaten Tangerang will be responsible for installing piped clean water supply in the planned project area. Currently, the water supply in Kampung Melayu Timur are shallow wells that were constructed by the locals with depths ranging between 1 – 2,6 m. Unfortunately, these wells are not reliable for continuous water supply due to its seasonal availability. In light of the joint cooperation and the (planned) provision of water supply in the target area, all wet sanitation options pass the this step (See Figure 15), and proceed to the second step of the screening. Nevertheless, it should be noted that the PDAM in Indonesia are still working providing continuous water supply (Lanti, 2006, Rietveld et al., 2000). Therefore, due to the uncertainties involved, the reliability of the water supply will be revisited in the next phase.

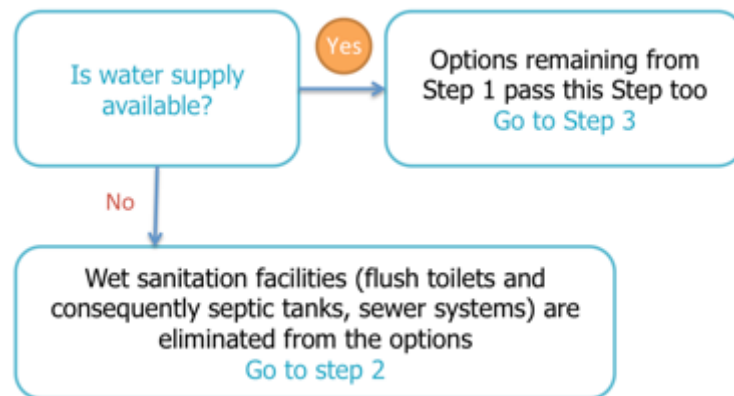


Figure 15 - Step 2 of the screening phase

3.1.3 Soil characteristics

The type of soil in Kampung Melayu Timur is not rocky soil and it is feasible for excavation. The soil type is porous silty sandy loam in the targeted project area, which allows infiltration; however the groundwater table level is high, and 88% of the community rely on the water from their wells as their clean water. In order to avoid water contamination, sanitation options relying on soil infiltration (Option 4, 7, and 8) are eliminated, whilst the remaining proceed to the next step (See Figure 16).

3.1.4 Available space

The available space can be calculated by subtracting the building area from the total land area owned by each household. The average available outdoors area of the households computed from the survey data (by subtracting the total land area with the area of the house); is 15 m²/hh. Where 3% of the households has available outdoor area less than 5 m² and 2% of the community has available outdoor area larger than 100 m². Unfortunately, the data and land ownership cannot be verified, as neighbors do not fence their dwellings, (with the exception of very few middle-higher income households). By referring to the survey data and on spot observations of the surrounding area, it can be concluded that not all dwellings have an outdoor space available for toilet implementation (See Figure 17). This eliminates outdoor (unshared) sanitation option, hence if private sanitation option was going to be selected, it shall be constructed indoors.

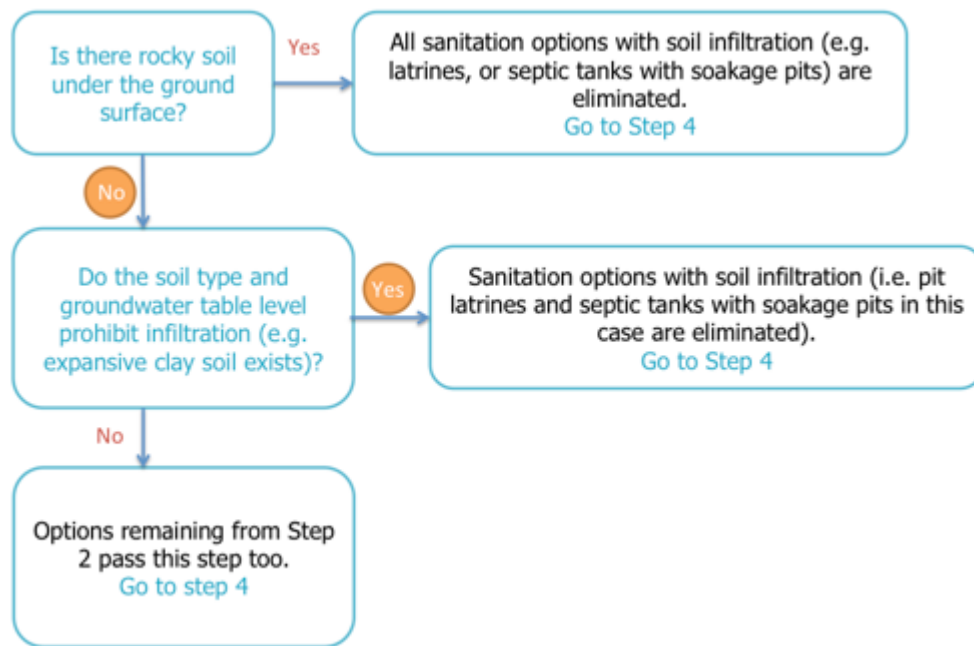


Figure 16 - Step 3 of the screening phase

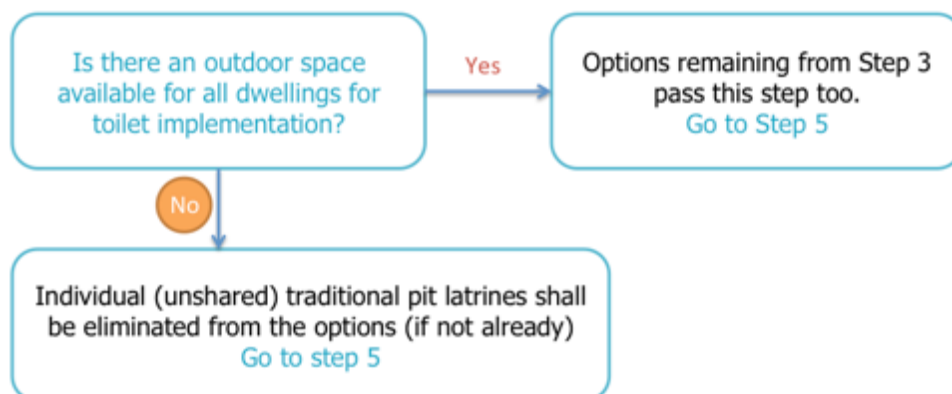


Figure 17 - Step 4 of the screening phase

3.1.5 Wastewater conveyance using gravity sewerage

In densely populated residential areas where there are limited space for individual on site sanitation (per household), a conveying system would be necessary to channel the domestic wastewater to a treatment of site in a (semi)centralized system (Crites and Tchobanoglous, 1998). In poor rural and periurban areas in developing countries it is highly not recommended to install the conventional sewers as they are very expensive; high capital investments as well as operation and maintenance costs. Alternatively, the option of implementing simplified or settled sewerage is more preferable (Bakir, 2001, Mara, 2003, Otterpohl, 2001, Paterson et al., 2007). However, it should be noted that the criteria to convey wastewater by gravity of a simplified sewerage is the presence of a minimum peak flow of 1,5 l/s to avoid blockage (with a 5% gradient in using 100 mm pipe). Presently the blackwater production of the community and its future 20-year projection is 10 m³/d or 0,1 l/s, which is significantly less than the required flow for a simplified sewerage (See Figure 18). Therefore, all options from Step 4 that use settled and simplified sewerage (Options 5, 9 and 11) shall be eliminated from the remaining sanitation systems.

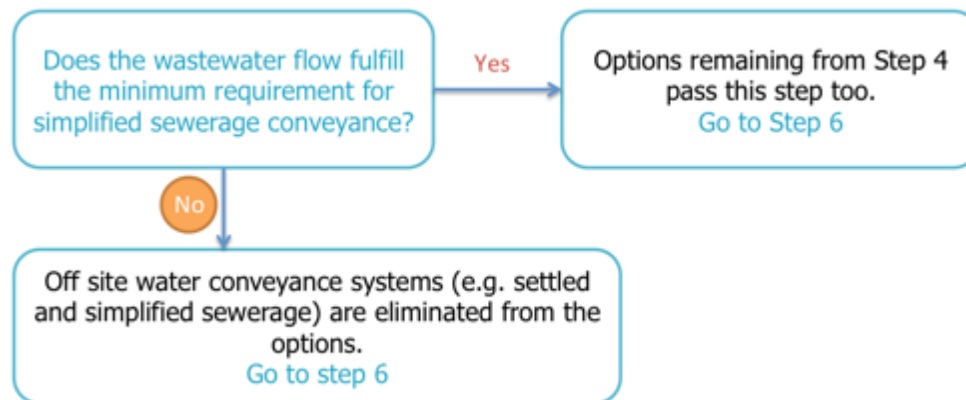


Figure 18 - Step 5 of the screening phase

3.1.6 Presence of a managing institution

In the current situation there is no centralized institution for the operation and management of the sanitation facility. This was one of the reasons of choosing extensive systems that will require minimum O&M. Nevertheless, a community approach has been planned to raise awareness through hygiene education for the pilot project. The socialization is aimed to assist locals to become active participants in improving the sanitation conditions of their area. It is hoped that high involvement from the communities will generate higher usability and local manageability of the planned sanitation infrastructure (See Figure 19). Based on the future socialization plan, it is considered that centralized institution will be established for the operation and management of the (communal) sanitation facility .

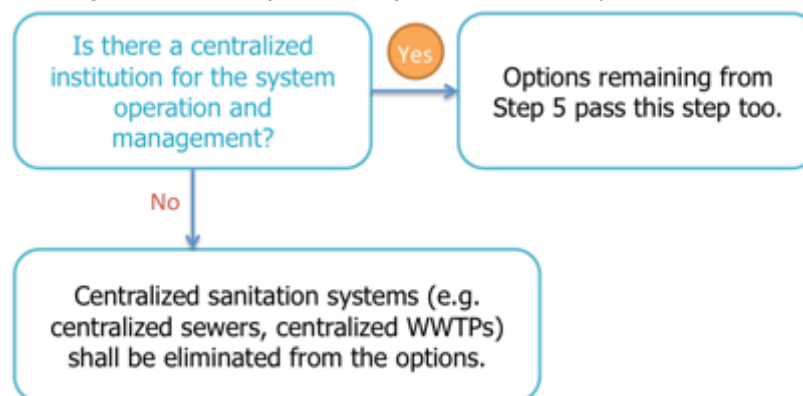


Figure 19 - Step 6 of the screening phase

The remaining sanitation options (see Table 5) ; pour flush toilets connected to a communal septic tank and constructed wet land; pour flush toilet wastes connected to a communal septic tank with integrated upflow filter; and pour flush toilets connected to a biogas digester; will be entered into the second stage of probabilistic evaluation process. They are all categorized as a shared public facility.

Table 5 - Sanitation systems that have passed the screening phase

No	Combination
6	pour flush – communal septic tank – constructed wetland
10	pour flush – communal septic tank – upflow filter
12	pour flush – biogas digester

3.2 Exposure to health hazards

The sanitation options that have passed the screening process; (6) pour flush connected to a communal septic tank and constructed wetland, (10) pour flush connected to communal septic tank and upflow filter, and (12) pour flush connected to simplified sewerage and biogas digester; will be evaluated in the following section using the criteria designed by Malekpour (2012). These criteria include the groundwater microbial pollution and the exposure of users to active pathogens in fecal matter and exposure of sanitation workers during maintenance.

3.2.1 Groundwater microbial pollution

As previously mentioned in Section 2, currently the local communities rely on shallow wells abstracting groundwater with very few already connected to the water service line of the local water utility company (PDAM). In addition, none of the selected sanitation facilities rely on groundwater infiltration for water treatment. Therefore, the risk of groundwater microbial pollution will not be included in the evaluation.

3.2.2 Exposure of users to fecal matter

The sanitation option that has been selected at the user interface is a pour flush toilet, which is the same for all three systems. This results in equal weights for user's exposure to fecal matter for all the three sanitation systems (Fewtrell et al., 2005). The exposure pathways for users of pour flush toilets include ingestion of excreta, dermal contact, contact with flies and inhalation of aerosols (Stenström et al., 2011). Based on the field survey, on average a person urinates once and defecates twice a day, ranging from 2 to 15 minutes respectively. According to Stenström et al. (2011), the contact time of exposure is normally less than or equal to the duration of the toilet visit. In this case, as locals defecate and urinate in open fields or atop gutters three times a day, the average exposure time per person is less than 45 minutes/day. The summary of the pour-flush toilet's exposure to health hazards for its users could be referred in Table 6 and Table 7.

Table 6 - Health hazards exposure using pour flush toilet (Stenström et al., 2011)

Pour-flush toilet	
Pathways	<ul style="list-style-type: none">• Ingestion of excreta• dermal contact• contact with flies and mosquitoes• inhalation of aerosols and particles
Population (ca)	260
Frequency (day ⁻¹)	3
Contact time (min/ca/d)	< 45

Table 7 - Risk of exposure using pour flush toilet (Stenström et al., 2011)

Options	Number of exposed	Frequency of exposure	Level of risk
6, 10 and 12 (Pour flush)	1 or several	Daily	High (dirty toilet)

3.2.3 Exposure to fecal matter during waste collection

This section evaluates the risks of exposure of the different types of sanitation options during waste collection (and maintenance). The people that are subject to such risks are the operator/maintenance worker mainly, and the communities (to a certain extent, during breaks etc.). The users are not included here, as they have been discussed separately in the previous section.

Workers are susceptible of being exposed to pathogens from fecal matter as they conduct regular inspection on the infrastructure as well as during waste collection. Such works opens up the opportunity of being exposed to health risks through exposure pathways to active pathogen in fecal matter; ingestion of excreta, dermal contact, contact with flies and inhalation of particles (Stenström et al., 2011).

As proposed in the works of Malekpour (2012), the potential health risk of the workers being infected from such exposures are influenced by: the concentration of the active pathogens at the exposure interface, the number of people exposed and the frequency of exposure and the contact time. By obtaining these data, a score (for each sanitation option) could be generated by multiplying the probability of risk exposure during waste collection with the percentage of population who is exposed. Nevertheless, these data were not gathered during the field study as it was not within the scope of this research.

A different approach of quantification is used by using the researches that have gathered extensive data on similar sanitation systems seen in Options 6, 10 and 12. Originally, Stenström et al. (2011) defines the frequency of exposure (based on each exposure pathways) as low, medium, and high, for exposures that are less likely, likely and very likely to occur, respectively. In addition the disease infection risk was also categorized as low, medium, and high that are dependent on the exposure pathways. Readers are then able to assess the health risks separately, based on its likelihood and then based on its disease risks.

The computation of the health risks in this report aims to combine these two factors as they are both important determinants (Stenström et al., 2011, Malekpour, 2012). By using this principle, the data are converted to numerical values, where 1, 2, and 3 represent low, medium and high respectively. This conversion applies for both the likelihood of exposure and the risk of disease infection during desludging and maintenance of the sanitation option. The two factors are then multiplied and summed up to derive the final result of the health risk of the sanitation options. The recapitulations can be referred in Table 8.

Table 8 - Risk of hazardous health exposures for the different sanitation options

Option	Treatment		Likelihood		Disease risk	Score
6	Comm. septic tank					
	Motorized emptying	High	3	High	3	9
	Constructed Wet (SSF)	Low	1	Low	1	1
	Transfer disc. Station	High	3	High	3	9
TOTAL						19
10	Comm. septic tank + upflow filter					
	Motorized emptying	High	3	High	3	9
	Transfer disc. Station	High	3	High	3	9
TOTAL						18
12	Biogas digester					
	Motorized emptying	High	3	High	3	9
	Transfer disc. Station	High	3	High	3	9
TOTAL						18

All three options require fecal sludge emptying within the components of the system. In Option 6, fecal sludge needs to be emptied from the septic tank (Mara, 1996). Furthermore, inspection works need to be conducted to the settled sewers and constructed wetland that opens up

exposure pathways to active pathogens. The workers are also exposed to health hazards during the transfer of the sludge at the discharge station. Spills, splatters and inhalation of the molecules are some of the ways that the workers may be exposed to fecal matter. In Option 10 the sanitation workers are involved in regular inspections of the simplified sewers, desludging the septic tank and transferring the fecal sludge to a discharge station. Desludging the septic tank could be done manually or using the aid of a motorized vacuum. According to Stenström et al. (2011) both methods possess the same likelihood and disease risks to the workers. Similarly, Option 12 also involves desludging; with the desludging of the biogas digester instead of the septic tank. The task of transferring the fecal matter to a discharge service point have been assumed, as it is more preferred in Indonesia compared to reusing the sludge (Informant BEST, SNV, personal correspondence). Although sludge reuse is considered as one of the objectives and benefits of installing a biogas digester (Widodo and Rahmarestia, 2008, Sasse, 1984, Pakarinen et al., 2008, Noyola et al., 2006, Kossmann et al., 1999), many have found it difficult to gain local acceptance. This is partly due to the fact that human fecal matter is considered *najis* in the Islamic world (a faith that is predominant in Indonesia), and others fear its safety levels in terms of being free of pathogens (Nayono et al., 2011).

In respect to the criterion of the health risks involved with workers during maintenance and desludging, Option 10 and Option 12 both are rated equally. Option 6 has a higher health exposure (5%) for the workers compared to the remaining two options. By conducting a sensitivity analysis (See Table 3 Appendix 1) changing the numerical values to represent *low*, *medium* and *high* risks show that the differences between the Options become reduced when a larger scale is assigned. For example, when low = 1; medium = 5; high = 10; Option 6 attains a total score of 201 whereas the remaining two Options both attain 200. Option 6 has 0,5% higher risk of exposure. When low = 1; medium = 10; high = 20; Option 6 attains a total score of 801 whereas the remaining two Options both attain 800. Thereby Option 6 poses a 0,1% higher risk than Option 10 and Option 12. If the scoring scale is low = 1; medium = 50; high = 100; The differences between the Options become very small and it can be deducted that all three Options poses the same health risk.

3.2.4 Final result on the criterion

The final result of this criterion depends on the exposure of fecal matter to workers during waste collection. The remaining factors; exposure of users and groundwater microbial pollution protection, were equally weighed among the sanitation options. Therefore, based on this criterion, Option 6 poses a higher health exposure risks compared to Options 10 and 12.

3.3 Accessibility

This assessment only focuses on the user's accessibility to the toilet and does not include the user's accessibility to the reuse centers as seen in the work of Malekpour (2012). This is due to the fact that only Option 12 have the potential to be reused; biogas energy and sludge, whilst the remaining were designed to not fulfill such an objective. All of the facilities are sanitation options that will be implemented in the same area (location), hence the user's accessibility will be rated equal for all the alternatives.

3.4 Reliability

3.4.1 Water supply reliability

The water supply reliability is applicable in all options as the pour flush toilet is used at the user interface. The reliability of the water service can be measured as the number of hours with water service divided by the total hours per day. It has been agreed upon that the water utility service of Kabupaten Tangerang (PDAM TKR) will contribute in the water-sanitation project in providing the connection for clean water in the project area. Due to the fact that all three

options have the pour flush toilets at the user interface, all of them are graded equally in this criterion.

3.4.2 Reliability of user's practice

Malekpour formulates the reliability of user's practice as the ratio of the number of incorrect practices that occur to the total number of incorrect practices opportunities. When using pour flush toilets, several incorrect practices include: staining the surrounding area, not flushing after defecating, and placing solid wastes into the latrine (causing blockage).

In regards to this criterion, Options 6, 10 and 12 have equal weighed as the pour flush toilet is used in all sanitation options.

3.4.3 System maintainability

Several components that make up maintenance activities include the expertise as well as the costs. Needless to say, the expertise needed to maintain all systems are comparable, therefore in this evaluation the focus will be on the cost of maintenance involved in Option 6, 10 and 12.

Table 4 in Appendix 1 lists the primary activities of each sanitation option as well as its frequency per annum. The sanitation systems are then compared based on the cost incurred during their maintenance. The cost involved are broken down to material and tools as well as man power. Presently the labor fee for 1 man hour is IDR 5000/ hour (BAPPENAS, 2010). The remaining data were gathered through personal conversations during the field study. There are several lump sum costs, namely the cost of emptying the fecal sludge by a third party as well as inspection of pipe and gas fittings. These costs have already included the man hour.

The material cost and the total labor fee for maintenance are added and then multiplied with the frequency of the activity per annum. The cost of all the activities are summed up to give the estimated total annual cost of each sanitation option. The summary of the cost calculation can be referred in Table 11. The results are then compared to the income of an average household (IDR 1000000/month). The cheapest O&M costs is Option 6, followed by Option 12 and closely followed by Option 10 with 5,6%, 8,2% and 8,3% of the average annual income respectively.

Table 9 - O&M costs for the different sanitation options

Option	Treatment	Cost (IDR ^a)	Total	% of annual income ^b
6	Communal Septic Tank	250000		
	Cons Wet (SSF)	425000		
			675000	5,6%
10	Communal Septic Tank + Upflow Filter	1000000		
			1000000	8,3%
12	Biogas Digester	980000		
			980000	8,2%

^a 1 Euro = IDR 12129 accessed with YAHOO! Finance in May 2012

^b More than half of the households (52%) has an income of \leq IDR 1000000. Therefore, average annual income is IDR 12000000

3.4.4 Proneness to flooding

The proneness of flooding relates to the elevation of the sanitation option and its chances of being flooded. An area has been allocated in this pilot project for the construction of the sanitation facility, hence, all three options are weighed equally in terms of its proneness to flooding.

3.4.5 Final result on the criterion

The final result of the reliability assessment is based on the maintainability of the sanitation options, whereby Option 6 is the most maintainable followed by Option 12 and lastly Option 10.

3.5 Sustainability

The following assessment will be focused on the compatibility of each sanitation option with the population growth. As previously mentioned, all three systems rely on a water supply, which, in accordance to the project's proposal, shall be provided by the local water utility service company. Therefore, the prospective water supply coverage for all three systems will be weighed equally.

In order to compensate for population growth, it is recommendable to design the treatment facilities with a 20 year projected capacity (Crites and Tchobanoglous, 1998). According to The Bureau of Statistics of Kabupaten Tangerang (2011) the rate of population growth in Teluknaga is 3.19%, hence with a current population of 260 people, Kampung Melayu Timur will have 488 residents in the area. The estimated blackwater (and flush water) is 20 l/ca/d, which results in a total of 10 m³/d.

Assuming that all sanitation options are designed to fulfill the projected inflow capacity of 10 m³/d, the required surface area (for construction) is sufficient for all three options. Based on the formulas adopted from the literatures (Crites and Tchobanoglous, 1998, Sasse, 1988) the estimated area for Options 6, 10 and 12 are 46 m², 10 m² and 33 m². The (estimated) constructions are not larger than the provided land of 50 m² for the pilot project. The calculations to estimate the required footprint of Options 6, 10 and 12 are can be referred in Appendix 2. Therefore, all three items are equally sustainable to serve the population growth.

Nevertheless, if projecting further than 20 years, Option 6, with the constructed wetland, will have to be expanded beyond the provided land for the pilot project. This will involve additional costs for land acquisition that would not be necessary for Option 10 and Option 12. Furthermore, population growth also requires land for development, hence making the option of expanding to another vicinity would be unfavorable.

Another aspect that need to be considered in assessing the sustainability of the sanitation options is the technology trend that is prevalent in Indonesia. Currently, the usage of biogas energy has increasingly become more popular in sanitation projects across Java. This was based on site visits in Jakarta and Bogor, which was further validated during interviews with the local authorities (BPLHD Kota Bogor, IUWASH). This is mainly due to the fact that the ever increasing population growth is followed by an increasing energy demand. The alternative biogas energy offered by biogas digesters have made this option more appealing in the public eye.

Therefore, based on the discussions above, the sustainability level (from the highest to the lowest) is in the following order: Option 12 > Option 10 > Option 6.

3.6 Final evaluation

The data input for the probabilistic assessment was not sufficient (limited availability of collected data in the field work) to fully implement the framework of Malekpour (2012).

The following Table aims to present the scores of the Options relative to one another, by making one of the options as the reference, *r*, giving a direct comparison. The scores of the remaining Options will be divided by the score of the option that has been selected as the reference. The Option that is selected as a reference is normally the highest or the lowest

scoring Option within a criterion and thus the option as the reference differs from one criterion to the next.

After evaluating Options 6, 10 and 12 based on the four criteria; exposure to health hazards, accessibility, reliability and sustainability, it could be seen in Table 10 that Option 6, which consist of a pour flush toilet followed by a septic tank and a constructed wetland, performs better in most criteria, apart from the sustainability of the sanitation facility. Option 12 with the pour flush toilet connected to a biogas digester comes second, followed lastly by Option 10 with the pour flush toilet connected to a communal septic tank and upflow filter.

Table 10 - Results of the (technical) assessment of the sanitation options

Evaluation criteria	Option 6	Option 10	Option 12
Exposure to health hazards	0,95 r	r	r
Accessibility	r	r	r
Reliability	r	0,52 r	0,55 r
Sustainability	<r	r	>r

To conclude that Option 6 is the best sanitation option, would undermine the issues discussed in the sustainability criteria regarding the disadvantages of constructed wetlands and problems arising from its future expansion.

Similarly, by considering that Option 12 with the biogas digester is the ultimate solution with the favorable alternative energy, is putting a high expectation that the biogas digester will successfully fulfill its reuse capabilities. A malfunctioning biogas digester, due to improper operation and maintenance procedures, could result in gas leakage as seen during field visits. When the produced biogas is not used and being vented out into open air, the air becomes polluted with CH₄, which is a greenhouse gas. Instead of promoting environmental preservation, a malfunctioning biogas will pose a reverse effect of environmental degradation.

It is therefore essential to design and follow the operation and maintenance procedures for all the sanitation options. Regular inspection and repairs of the infrastructure, will keep the systems to function appropriately, avoiding unwanted pollution and keeping track with fulfilling the objective of creating a healthy environment free from hazardous health risks posed by untreated wastewater.

4 User's Perception

*"Don't give people what they want, give them what they need."
(Joss Whedon)*

It has been found that the importance of the user's perception and participation is often underestimated in sanitary reforms (especially in developing countries). The general assumption that target adopters are not aware of their 'true' (health and hygiene) needs have become a form of justification for external actors to impose their ideas on the 'right' solution (Avvannavar and Mani, 2008, Bebbington et al., 2006, Lay, 2007). Such method of imposition raises questions as to whether it would produce a sound result.

This chapter deals with uncovering the user's perception on the sanitation reforms that have been constructed within their respective areas. It aims to gain further insights on the correlation between the user's needs (of a sanitation reform) and the usability of these reforms. Three different case studies have been used to identify the trend between the two aforementioned factors. By using the data obtained from interviews, focus group discussions, and on spot observations, this section further investigates the remaining factors that may form the link between a user's need and the user's usability of a sanitation reform.

4.1 Needs and usability

*If needed then used
If not needed then not used*

This section aims to uncover the relationship between the user's perceived need of a sanitation reform and the usability (by the users) of the sanitation reform. It investigates whether or not a direct causal relationship (as shown above) exists between the two by using three case studies. These areas have sanitation facilities in the form of a washing-bathing-defecating (*MCK*) facility. The findings during interviews and Focus Group Discussions (FGD) with the respondents will be presented in the analysis. The more detailed transcript can be referred in the Appendix 3. As previously explained in Section 2, the interviewees' names are not disclosed. Instead, a coding system was used to identify the respondents. Each interviewee is referred with two letters, whereby the first letter indicates the site where the respondent resides, and the second letter is simply using the alphabets to differentiate respondents originating from the same site.

4.1.1 Case Study A

According to the local cadre, Informant AA, most of the locals in Site A do not own private toilets at home, and they perform open defecation by the stream. The locals were very opened in disclosing their habit as can be seen in the Appendix 3.

When questioned regarding the sanitation facility (in the form of a washing-bathing-defecating facility: *MCK*), Informant AA mentioned that the construction of the *MCK* facility had been discussed in Site A. In fact, there was a petition that was passed around among the community members for the construction of the facility.

"People were informed about the construction [...] Local leaders talked about it, signatures were asked. [...] There were community discourse (regarding the *MCK* facility). It was also the local community that asked for it, and then also from the District Authority *Cipta Karya*. We had discussed it with RT II (sub-village II)."

Informant AA, September 2012

This information was also validated among other members of the community, who recalled that they were aware of the *MCK*'s construction (See Appendix 4). To determine whether or not the project was initiated as a top down approach; whereby local leaders gathered in a discourse

and distributed the petition to ask signatures from the locals merely as a means of informing them, the wants of the locals should be ensured.

The following statement resolved this ambiguity, showing that locals not only knew about the *MCK* facility, but they also needed it.

"It can be said that almost everyone needs it (a place to defecate/ the *MCK* facility) [...]."
Informant AD, September 2012

The above statement was followed by not only agreeable nods among other members, (which could have inferred 'I am following what you are saying' or 'I understand what you are saying'), but also supported by mutters of "*Iya*" or "Yes", among the women participating in the Focus Group Discussion.

One could argue that it may be a form of collective action, as the sayings "Like my neighbor", "I also follow (others)", "Everyone was also doing it", were generally found during the discussion or interviews with participants in all field sites. It provides a clear evident that Indonesian are a group of collective, whereby their innate desire to act is stimulated on how others behave in their surrounding (Rogers, 1995)

Nevertheless, the following-the-other behavior is less likely to occur since the need to defecate and urinate is a an important personal need and people would speak for their own interests instead of sheepishly following the others.

Therefore, it could be inferred that not only were the locals aware of the construction, but they also wanted to have the construction of the *MCK* facility.

Unfortunately, prior to the completion of the construction, the head of the sub-district (*Ketua RT*) had moved and reassigned to another province (personal conversation with the local authority). The *Ketua RT* was already designated to be in charge of the O&M as well as training and socializing to the rest of the community members about the *MCK* facility. Hence, a proper handing over of the facility to the remaining of the communities did not occur, which lead to its abandonments.

As a result, the *MCK* facility had many issues and the majority of the participants of the FGD gave a low ratings for its cleanliness and its purpose on fulfilling the sanitation needs of the community.

"Sometimes there's hardly any water (at the *MCK* facility), especially after noon. It goes on and off. [...] We would like to do it (excrete) in a bathroom. But then we go there in the afternoon and see that there's no water, so we head back (out from the *MCK* facility). And then in the evening, once (I) went there with my husband... it was dark, there was no lighting... and also no water. *Ih...* then we head back out. We don't know why (it's like that), perhaps because there is no caretaker, well we don't know ma'am. [...]"
Informant AD, September 2012

"The *MCK* facility here, you see ma'am, is not being used because it is rather far. Maybe the one under the bridge is more convenient."
Informant AT, September 2012

Based on the interviews and on-spot observations during the field study, it was evident that the locals did not use the facility, and the state of the *MCK* was not very clean. Needless to say, during the FGD there were two participants who claimed that they use the *MCK* facility. They appreciate the privacy when urinating and defecating at the *MCK* facility, especially when there are construction workers by the stream.

"I would rather pay the (IDR) 1000 rather than being embarrassed."
Informant AT, September 2012

The locals were honestly disclosing their habit of open defecation, as can be seen below:

"I go to the big stream... [...] Well, excuse us miss, you see we don't have private toilets here. So we just squat (wherever) [...] (slippery grounds) it's risky... a risk we take [...] We are used to it. There aren't toilets (at people's homes) here. (When needing to go in the middle of the night) Then we just do it there [...] Find (a place to excrete) wherever is nearby [...] The rented flats don't have their own toilets, so they go to the front... the gutters (to excrete). That's true right? Compared to holding it back, it's for our own health right ma'am AA?"

Informant AD, September 2012

"If (I) can't take it anymore, then I'm forced to go outside... anywhere close"

Informant AI, September 2012

Interestingly, one of the participants excused their behavior due to the lack of sanitation facility in the neighborhood. Although there is an *MCK* facility in the area, however it was not perceived to be present by the community members because it was not fulfilling their expectations (no water, no lighting and dirty). This is seen in the following statement:

"It's been this way for a long time. Well, we don't have the facility, If there was, then perhaps we wouldn't have to be doing what we are doing now right ma'am?"

Informant AD, September 2012

In summary, there is a perceived need for a sanitation facility. However, the *MCK* facility that is present in the area is not being used because it does not fulfill the expectations of the local communities. This is was beautifully summarized with the following statement:

"It can be said that almost everyone needs an *MCK* (toilet). But people seldom go there (to the *MCK* facility)."

Informant AD, September 2012

4.1.2 Case Study B

The washing, bathing, and defecating (*MCK*) facility in Study Case B was not constructed upon the initial request of the locals. This was seen in the following statements:

"Well... I didn't know about it (the plan to construct an *MCK* facility). But I'm not sure whether to disagree or not [...] The existing *Musholla* (praying place)⁴ is far... We all agreed to build a *Musholla*."

Informant BA, September 2012

"Yes, we needed a *Musholla*, because that's something that we don't have. None at all (in our area)... This is the nearest *Musholla*."

Informant BB, September 2012

"What we had agreed upon was actually the construction of a *Musholla*... A lot (of the community members) agreed for a *Musholla* [...] Many did wonder, "How come it was not the *Musholla* (that was constructed)?"

Informant BC, September 2012

"*Musholla*, indeed... It's quite a distance to come here when we want to pray."

Informant BD, September 2012

From the above statements clearly a place to pray, *Musholla*, was initially preferred by the locals than the *MCK* facility. The reason being that the majority of the locals already have toilets in their own home. The *MCK* facility was initiated and discussed among the local village leader according to Informant BC. Informant BC is a mother who owns a kiosk in the area, and her husband was once elected to be the head of the subdistrict (*Ketua RT*).

The head village (*Kepala RW*) also made it a point during the introduction (at the beginning of the field study), as he guided along the visit and showing the appalling condition of his neighborhood. He expressed that his concerns led him to propose for the *MCK* facility to be built in the area.

The *MCK* facility was constructed in 2010 and the responsibility to maintain the facility was taken up by the *Kepala RW* and the *Ketua RT*. The community members agreed that the cleanliness of the *MCK* facility is commendable during the Focus Group Discussion (FGD). The construction of the *MCK* facility received positive remarks from the locals.

"I mean, I do agree in a sense that... well, it's good so that it helps with our PAM water fees. Like, you know, we can go to the MCK and minimize our usage (at home)."
Informant BA, September 2012

"At least there (the MCK facility) was a shield guarding the edge. You can see that there's a huge gap, and we feared that our kids would fall if they were playing there."
Informant BB, September 2012

"I used to live at my parents' and we all did our washing at home. So, having the MCK (facility) was really good, because then it was more spacious to do our washing. Back at home, the bathroom is small, so we scrambled to get a spot. But that wouldn't be the case anymore if there's a public (MCK) facility. Those who wanted to shower (at home) could do so, and those wanting to do their washing could go to the MCK (facility)."
Informant BD, September 2012

As seen in the above statements, users who tried the *MCK* facility considered it to be useful. It was useful as a source of clean water for washing and it made the area, which was located at the edge of a stream, more secure. However, it was not favorable to use the toilet in the *MCK* because locals already have their own toilet at home, and it is inconvenient to be disrupted when use a public toilet as shown in the following statements.

"It's not that it is not clean enough, but it's just troublesome. Like... if we were just doing our business and pooping, then someone would be knocking (on the toilet door) 'knock...knock...knock...'. We were interrupted."
Informant BA, September 2012

It doesn't feel comfortable (being interrupted whilst defecating)."
Informant BB, September 2012

Nevertheless, Informant BB mentioned that the toilet of the *MCK* facility is used by her family, especially during the mornings, when her own toilet at home is crowded. She also emphasized the benefit of having an accessible toilet in the *MCK* facility for a large family as she commented on Informant BC (who claimed that she don't use the toilet):

"Of course BC uses the toilet at (her) home. There's no need (to wait in line) when there's only 3 people (in the house) right?"
Informant BB, September 2012

Presently, the *MCK* facility is rarely used by the locals of Site B as community members have began connecting to the water service line of the PDAM (*PAM* water). It has become more convenient to have the in house piped water in their own homes.

Well, there are only a few people using the MCK facility nowadays, because most of us have our own PAM water."
Informant BA, September 2012

The present users (of the MCK facility from B) aren't that many anymore, the number decreased because people have installed the *PAM* water (connected to the water service line of the PDAM). You can say, almost everyone in our community. [...] Well, sometimes, you see it depends, perhaps if we don't have enough water (at home) we'd go running back there (the MCK facility) again.
Informant BB, September 2012

As for the future usage of the *MCK* facility, the participants of the FGD in Site B all mentioned that they do not know if they were going to use the *MCK* facility again. They may be inclined to use the *MCK* facility again if the monthly water fee of the *MCK* facility is lowered, or if there's a water cut from their in-house water supply.

Lastly, as it was mentioned in the methodology, Site B was selected based on the recommendation of local authorities (as it was claimed to be a successful example of a sanitation reform). On the contrary, it was found during the field visit that it was not the case. The biogas digester that had been used since 2010, hence already producing biogas energy, had never been desludged and the biogas stove had never been used by the local community. This in fact poses risks to the environment, as the biogas in the form of methane is being released to the atmosphere.

4.1.3 Case Study C

On the contrary to Site B, the residents of Site C are still relying heavily on groundwater abstraction (wells) for their water sources, with very few locals connected to the water service line (Informant CB, September 2012). The well is a sufficient water source for daily use, (washing, bathing and cooking). For drinking water, some of the locals are no longer consuming the well water, and instead have opted to either buy water gallons from vendors.

"Yes, we do have both a washroom and a toilet. But the water from the well is only used for washing and it is not used for drinking because we can taste the soil (from the groundwater) as we sip the water. Yes, you see before we could use the well water for cooking [...] Even though the taste was slightly off. Afterwards we began consuming the water (from the refillable) gallons. I am the one that usually purchase it for the family. Now we are consuming up to 2 gallons a week."

Informant CB, September 2012

"I mean, here we are not lacking clean water. However, during the last 5 years, I don't know why, but the well water hasn't been so good. Even though I haven't gotten to the stage of checking (the water quality) to find out the cause (of the water degradation), we've simply stopped using it as our source of drinking water, especially for cooking, but never for drinking."

Informant CA, September 2012

The poor quality of the well water had led Informant CA to pay for water from a neighbor that is connected to the water service line. She pays a retribution fee each month for her usage. The locals in Site C washes their clothes by the stream as it is spacious, and the water is more abundant.

The locals are not performing open defecation. Informant CA and CB stated that they have a toilet and washroom in their home.

Initially the locals of Site C was not aware that there was an *MCK* constructed at Site B. When the locals knew about it, they were eager to use it. However, locals were hesitant as they belong to a different village.

"From the beginning. That's why, you see at the beginning I didn't know. Well, at first it was one day, two days, and one week, I didn't know that there's an *MCK* facility. Well, I do know that there's an *MCK* (facility), I even knew when it was buing built, but was it allowed for the locals from this area? Was it especially for the people in *Kotamadya*? I mean, here is the *Kabupaten*. And then I heard, "It's allowed, it's allowed" they said. Ofcourse, immediately I asked the *Pak RT*. *Pak RT* used to pass by, "Am I allowed to use it (the *MCK* facility)?", as we're from the *Kabupaten*. "Go ahead ma'am." like that. And then (I asked) also *Pak RW*."

Informant CA, September 2012

"No, initially we were not aware that there is an *MCK* facility [...] It is very difficult here, if there is no *MCK* facility, we will be clueless."

Informant CB, September 2012

The locals of Site C that wanted to use the facility was listed down by one of the caretaker, and each household had to pay the regular monthly usage fee similar to the locals of Site B. The locals of Site C are very grateful for the accessible *MCK* facility, and all the interviewed members gave it the highest rating (5) in terms of the facility fulfilling their needs. The ones that have enrolled in the monthly list, have stopped washing at the stream, and instead they go to the *MCK* facility.

"Well, trully for me Miss, I am so grateful. If there's no MCK, My goodness... I don't know, I am particularly, you know [...]. If sometimes, well, there's a lot of people at home during the holiday... Well, I, because I need it, well I just go there, it doesn't matter. And... I wash myself there too sometimes."
Informant CA, September 2012

"*Alhamdulillah*, there is the *MCK* facility. Now we take the clean water from there, but we are still buying the refillable water gallons [...] We are extremely happy with the *MCK* facility."
Informant CB, September 2012

When asked about their usage, all the interviewed parties claimed that they will continue to use the *MCK* facility in the future.

4.1.4 Concluding remarks

Based on Case Studies A, B and C there is in fact no strong correlation between the perceived need of a sanitation facility and the usability of the sanitation reform itself. The question that remains is *Why?*

By approaching to find out the casualties as to why users do not use such reforms (even) when they deemed it a necessity, the research shows that there are many influencing factors that led to the continuance or discontinuance (decision to a committed adoption) of using the sanitation reform. By reading through the script, the intervening variables include, the maintainability of the facility, its affordability, water accessibility as well as the level of convenience offered. More descriptive details of these factors can be found in the next subchapter.

4.2 Intervening factors

Past researches have identified the KAP-gap, which is the knowledge-attitude-practice gap. According to Roger (1995) one of the reasons why the knowledge of a social reform is not followed by a favorable attitude and result in practice due to the fact that the reform lacks acceptance 'owing to certain undesirable side-effects that are associated with them in the minds of potential adopters'.

By studying the result of the field study, several key factors that are able to generate a favorable (or unfavorable) attitude of the users towards the sanitation facility are the *MCK*'s maintainability, affordability, water accessibility and convenience. Similar to the previous discussions, this section will refer to statements from the direct users (gathered during interviews and FGD), in order to confirm the existence of the intervening factors. A brief discussion will also be provided on the reason why these factors are present.

4.2.1 Maintainability

An *MCK* facility that is well maintained, usually by a designated caretaker, will prove to attract users. This is evident by comparing the *MCK* facility present in Site A vis-à-vis the *MCK* facility in Site B. The latter is maintained by the *Kepala RW* and *Ketua RT* and it received a high rating (based on FGD and interviews) for its cleanliness by the users from both Site B and Site C. On the contrary, Site A, that had a poorly maintained *MCK* facility made the locals reluctant to use the facility and preferred other options such as defecating in the open next to the stream. Complaints were made on the absence of a caretaker that could have helped maintain the facility, such as the following:

"There's no one maintaining the facility... No one."
Informant AR, September 2012

"[...] There (the shed by the river) is clean, whereas here (the *MCK* facility) is dirty."

Informant AA, September 2012

“[...] If there was a caretaker maybe it would be cleaner right Ma’am? If there’s someone responsible for it, then maybe...”

Informant AD, September 2012

4.2.2 Affordability

Ideally, a functioning *MCK* facility charges retribution fee to its users in order to pay for the O&M fees, namely the water use, electrical bills (for lighting), repairs as well as the salary of the caretaker (if present). These O&M fees are evenly distributed among the users of the facility. According to (Mungkasa, 2008) and field visits to cities in the West Java, Banten and DKI Jakarta provinces, communal *MCK* facilities generate money by either charging the fee per usage per person (fees vary in terms of washing, bathing or defecating) or by offering to the communities a more affordable monthly plan. The charge ranges from IDR 5000 –15000 per household per month. By enrolling in such payment, all members of the household have unlimited access to use the facility.

At first glance, IDR 15000 seems very cheap as a monthly fee for the *MCK* facility. Users can wash, bathe, defecate and use as much water as they would like from the facility. Nevertheless, this still remains an issue for the locals of Site A, who are categorized mostly as the middle to low income generators. The average monthly expenditure (based on the FGD) is IDR 900000. This means that the monthly *MCK* facility fee would be 2% of their expenditures. This fee must compete with daily consumption, transportation, water and energy bills, school fees and additional debts, which are far more important priorities for the locals, hence lowering the willingness to pay for the *MCK* facility. The high cost of the monthly payment for using the *MCK* facility in Site B have discouraged users to continue using the facility, which can be seen in the statements below.

“So... you see, because the *MCK* facility fee is now IDR 10000 – 15000, then I don’t end up going there, and instead I use the water source at home. [...] Well, at least we were hoping to suggest for an affordable monthly fee [...] Perhaps now it could be considered to lower the fee down to IDR 5000 per month. I mean, we’re only doing our washing there.”

Informant BA, September 2012

“Well, if we don’t have the money to pay for the *MCK* facility, then we don’t dare to use it.”

Informant BC, September 2012

Similarly, in Site A, locals are already defecating in the open for free. It becomes difficult to try to encourage them to opt for a *MCK* facility where there is a retribution fee for its usage as mentioned in the following:

“One of the reasons why people are reluctant to use the *MCK* facility is because of the fee. Why should they pay when they can go for free by the river?”

Informant AA, September 2012)

4.2.3 Water accessibility

One of the main advantages of gaining access to an *MCK* facility is the unlimited water supply. This was seen from the positive feedbacks of users in Site B and Site C for the available clean water in the *MCK* facility of Site B. Some of the locals bring are keen on washing at the facilities as it provides more space; others are using it when there are large gatherings at home, and the use of a spare toilet is convenient than having to wait in line at home; and other locals have also carried some of the water from the *MCK* facility back home for consumption.

“*Alhamdulillah* (praise be to God), there is the *MCK* facility. Now we take the clean water from there, but we are still buying the refillable water gallons.”

Informant CB, September 2012

"Well, sometimes, if, like I mentioned earlier, here it can take a while for the water to flow out, perhaps after *Maghrib* or prior to the *Isha* prayer time, we would take our *wudhu* (cleansing before prayers) there (at the MCK facility) but not to bathe. Well, afterwards we grab some water (to the house). That's all. But not every night."
Informant CA, September 2012

On the contrary, the MCK facility of Site A lack maintenance and water availability. This is unattractive for the locals as Indonesians are accustomed to perform anal cleansing after defecating, or commonly known as 'washers' (Mara, 1996). When (potential) users see there is no water available, they immediately leave the facility and find someplace elsewhere that has water, such as the stream.

"[...] When we see the basin is empty, then that's it, we leave (the MCK facility)."
Informant AI, September 2012

"Sometimes there's hardly any water (at the MCK facility), especially after noon. It goes on and off. We would like to do it (excrete) in a bathroom. But when we go there in the afternoon and see that there's no water, so we head back."
Informant AD, September 2012

4.2.4 Convenience

The user's convenience is influenced by many factors. In this study, the factors include presence of lighting on the pathway, the distance, and the privacy offered by the MCK facility. Notably, the user's level of convenience is positively correlated with the maintainability of the system.

The user's unsatisfied expectation of the MCK facility, for example when there is no lighting, or if they have to walk quite a far distance, (see statements in Section 4.1.1) decreases the convenience of using the facility. This will lead users to find options that are more convenient, even if it meant having to defecate on open gutters; which is nearer than going to the sanitation facility.

In terms of privacy, going to a communal toilet is less convenient than going to a private toilet. There are issues with waiting in line due to the limited latrine that is available in the MCK facility. This means that each user cannot linger and are (at times) rushed when defecating as shown in the statements below. In addition, people become uncomfortable when defecating, as the unpleasant sound and smell may be detected by others especially if there are only one or two latrines, where the level of anonymousness is very low.

"It's not that it is not clean enough, but it's just troublesome. Like... if we were just doing our business and pooping, then someone would be knocking (on the toilet door) 'knock...knock...knock...'. We were interrupted."
Informant BA, September 2012

It doesn't feel comfortable (being interrupted whilst defecating)."
Informant BB, September 2012

4.2.4 Concluding remarks

In conclusion, the intervening factors greatly influence the users' desirability in using a sanitation facility. Although the users deemed it necessary to have a sanitation facility, when their expectations on the facility; its maintainability, affordability, water availability and convenience are not met, then they would be less inclined to use the MCK facility. Therefore, public interaction during the design and construction of the facility is eminent. These include, public hearing and focus group discussions with the community. This is done to ensure the fulfillment of both the users' needs and expectations and thus result in optimal usage.

5 Discussions

5.1 Selecting sanitation options based on technical feasibility

5.1.1 Strengths and weaknesses

One of the distinctions of the decision making tool that have been developed by Malekpour (2012) is that "Absolute judgments are replaced by probable assessments as it tries to keep its distance from simplifying the reality by artificially making the uncertain certain."

Unlike the decision-making tools that use algorithm or multi-criteria analysis (Mara et al., 2007, Mara, 1996, Garfi and Ferrer-Marti, 2011, Bhattarai and Starkl, 2005), whereby *Yes – No* flowcharts navigate users to one sanitation option (that is most suitable), the sanitation options in Malekpour's framework are evaluated based on the probability that the expected outcomes of selecting a sanitation facility occur in practice. The framework's strength lies on the fact that users do not oversimplify reality; by making the uncertain certain (Malekpour, 2012) or be influenced by the (theoretical) benefits of a sanitation system instead of its true performance in the field), which hinders them from making a sound judgment.

In comparison with the available decision making tools for sanitation systems, Malekpour (2012) adopts a screening phase based on the technical feasibility of the system in the project area. This is done to eliminate facilities that would not function appropriately under local conditions (ground water table, soil conditions, etc.). Similar pre-screening approach have been utilized in several decision making tools (Ridgley, 1989, Louis and Magpili, 2007, Katukiza et al., 2010) to short list the systems for the next evaluation phase.

Although the method's main objective is to assess the likelihood of the expected outcomes of a sanitation facility in practice, the screening process relies on expertise in deciding which sanitation systems shall be included in the screening phase by taking considerations of the local conditions. A sound knowledge of the different types on sanitation options that are available is necessary during this phase (Malekpour, 2012), however it is often the case that experts tend to 'pre-select' (before even entering the screening phase) based on their (intuitive) judgment formed through experiences (Mara et al., 2007, Loetscher and Keller, 2002, Denham, 2012). The cognitive reasoning behind the decision (to pre-select) is greatly influenced by information received during the observations of the (social and physical) settings of the project area.

An example, in this study, could be referred during the screening phase based on the water supply availability. The presence of water connections in the area (in order to include or eliminate water-dependent facilities), is not a static condition. In this joint project, the local PDAM agreed to participate by supplying water to the project area, whereby new water connection lines shall be installed, which (potentially) will alter the current state of water supply availability in the area. Nevertheless, it cannot be guaranteed that there will be continuous water supply owing to the fact that the past experiences of the PDAM water distribution service have not been certain. There have been many reports and complaints made by consumers of PDAM in various provinces in Indonesia, as the water supply services still needs to be enhanced further (Rahayu, 2005, Kurniawan, 2008, Endriani, 2013).

Inclusion of water-dependent sanitation options is an optimistic approach in viewing with the unpredictable water supply service, and eliminating water-dependent sanitation options would be unsuitable for the community that relies on anal cleansing (Malisie, 2008, Drewko, 2007). Due to the fact that the social receptivity of an introduced technology is very important in influencing its adoption (Yacoo and Whiteford, 1994, Prokopy, 2005, Nance and Ortolano, 2007, Kleemeier, 2000, Ellerman, 2009, Chavis and Wandersman, 1990, Carter et al., 1999), it was then decided that the water-dependent sanitation facilities passed through the screening phase to be further assessed in the following phase.

One of the obstacles in applying the framework by Malekpour (2012) in this research is the necessity for large data. The general guideline of the required field data listed by Malekpour (2012) could be referred in Table 1 of Appendix 1. Several of these data were not gathered during the field study due to the limited time and scope of this study. Furthermore there is a lack of inventory in Indonesia on the thorough evaluation of the sanitation options available (Nagib et al., 2002, Hardono, 1995, Adisasmito, 2010).

The likelihood of the expected outcomes are evaluated by gathering past and present data as the input. When a sanitation facility is not yet present in the area, monitoring data should be gathered from other locations with resembling social settings. Similarly, when assessing the Reliability criteria; for example the average hours of water supply;

Unfortunately, the data was scarcely available to allow full implementation of this framework in this research. The technical aspect becomes more concentrated in the screening phase (i.e. to eliminate sanitation chains based on functionality of local conditions), resulting in possible subjectivity (based on the field study and literature review) of pre-selecting the available sanitation options. This method moves away from the original concept of Malekpour's framework, which aims to 'quantify the probabilities of specific outcomes' hence avoiding intuitive judgments.

5.1.2 Modification of the framework by integrating social aspects

Evaluations on water and sanitation projects where community participation have been promoted by involving the users during the decision making stage showed that users (who may not have the technical expertise) were able to short list sanitation options that were technically feasible with their local conditions (Sara and Katz, 1997, Katukiza et al., 2010). The selection process made by the potential users was not technological based, but more on the services provided (Sheth et al., 1991, Altaf and Hughes, 1994). Different methods of participatory evaluation were used (Narayan-Parker, 1993) presenting the sanitation systems with visual aids of drawings, pictures as well as having oral presentations and discussions on the benefits and drawbacks of the various sanitation options. This challenges the principles seen in many decision-making frameworks (Kvarnström and af Petersens, 2004, Helmer et al., 1997, Evans and Saywell, 2008) where the process of screening for sanitation options based on its functionality ought to be conducted by the experts.

The works of Louis and Magpili (2007) and Ahmad (2004) have focused on the inclusion of the social aspect in their frameworks. In addition to the (managing) capacity required in the technical assessment, community assessment was also conducted based on their local capacity in accepting and managing the proposed sanitation systems. The findings using qualitative analysis of the community (capacity : high, medium, low) are translated into numerical values, whereby the resulting community's managing capacity matched with the results from capacity required level from the technical assessment.

Other decision-making tools that are more sensitive towards the social receptivity of the sanitation systems include the works of Altaf and Hughes (1994), whereby the assesment is based on the user's willingness to pay (after being thoroughly informed of the different characteristics of the sanitation systems); and the inclusion of users' preference in the decision making-framework by Katukiza et al. (2010) as seen in Figure 20.



Figure 20 - Decision-making framework (Katukiza et al., 2010)

Similar to the framework of Malekpour (2012), the framework of Katukiza et al. (2010) begins by short-listing a selection of sanitation systems based on whether or not it would be technically feasible to be implemented in the project area. In the next phase, the remaining options that have been screened will proceed to be ranked by the experts (social scientists, engineers, public health specialists and institutional specialists) as well as being rated by the users in a Focus Group Discussion; whereby the sanitation options are compared on a pair-by-pair basis for preference. The two sets of results are combined to attain the final ranking of the sanitation systems.

Based on the findings of this research, several measures could be included in the framework by Malekpour (2012). Firstly, the integration of the socio-cultural aspects in the screening phase (such as whether or not the locals conduct anal cleansing; whether or not the locals accepts the reuse of treated fecal sludge).

Secondly, prior to the probabilistic evaluation phase it should also be investigated on the preferences of the users (by using the participatory assessment discussed earlier) of the different sanitation options. FGD and open forums allow users to become familiar with the options that are available and be acquainted with the benefits, drawbacks and the O&M responsibilities that come when selecting a particular system. By including the users in the selection process, this would avoid users from feeling left out and suspicious that they have not been given the best option (Lüthi et al., 2011). It should be noted that higher user participation in mobilization and decision making will induce a higher demand for a project (Kleemeier, 2000).

Lastly, the inclusion of users was not possible during the screening phase, the final resulting sanitation options that have been evaluated through the probabilistic phase should be presented to the users. It should be ensured that the findings of the evaluations are reformatted into (comprehensive) information that can be well understood by the local users, (albeit the difficulties in depicting results in terms of probabilities).

The social aspects and the habits of the users ought to be integrated in the screening phase. In addition, selecting a system based on its technical feasibility and taking into considerations of the uncertainties (eliminating) the uncertainties involved in the operation and maintenance of the facility is just as important as the receptivity of the system. Mara et al. (2007) states that

the suitability of a technology with the cultural/social aspect of the potential adopters is eminent.

5.2 Gaining user's perceptions and requirements of sanitation reform

Qualitative analysis had been chosen to assess the case studies solely for its abilities to allow researches see the phenomena from the point of view of their subjects (Stanton et al., 1987, Johnson and Onwuegbuzie, 2004, Bryman, 1984). This is particularly important when trying to understand the behaviors of the local users. Questions evolving on *what?* and *why?* - Relating back to the objective of this research - to find out what is the current habit of the users, why certain behaviors are observed and to abstract what the true requirements of a sanitation reform (based on the preference of the users).

On the contrary, if the method opted was through series of questionnaire and simply asking a set of questions upfront to the local communities (in a structured interview), the findings gathered would be in quantitative forms that are 'warranted' and generalizes the community (into a set of bar graphs and percentages), whereby the researcher constructs the baseline picture whilst being segregated and detached from the local communities (Sieber, 1973, Onwuegbuzie and Leech, 2005, Bryman, 1984). This 'warranted' results of such analysis is at times criticized as a "superficial view of the social world" (Bryman, 1984).

An example of a missing link in the findings can be found in the baseline survey conducted by IUWASH in April 2012 Figure 10. The percentage of the respondents that claim to have their own private washroom and toilet is 40%. In addition, 8% of the community admits to share toilets and washrooms owned by other members of the community. 35% admitted to perform open defecation. From the same survey, it was found that only 40% of the communities owned septic tanks. If the remaining respondents that claim to have washrooms at home with no toilet (17%) were to be investigated, it could be determined whether or not these households also practiced open defecation. Hence, the proportion of the community that performs open defecation may increase from 35% to 52% (which is a majority of the area). Furthermore, such percentages do not reveal the reason of certain behaviors and practices of the community (open defecation).

A generalization of the assessed (quantitative) data was also made by the local authority who acted as the contact person to the case sites in the West Java Province. Initially at the beginning of the field study, the selection of Site A and Site B was determined on the operating levels of the sanitation facilities (constructed in 2010 and 2009) based on the assessments of the local authority; whereby the two sites were of opposing extremes with Site A assessed as very poorly maintained and Site B as very well maintained.

Nevertheless, when the researcher observed and studied both areas, both sanitation facilities in Site A and Site B were not performing as it should be. In Site B, the sanitation facility had clearly been abandoned. However in Site A, although the facility was being used for its water supply for washing (and 1 public latrine); the biogas digester had not been emptied since its construction in 2009 and the produced biogas is not being used at all and simply being vented out into open air.

Similar to the findings of Nance and Ortolano (2007) and Nance (2005), the researcher could never find out truly what is good practice or bad practice until they have personally observed and investigated the site. Many times the appraisals of project performance does not accurately depict its true performance.

Furthermore, the ability to extract data using qualitative analysis was found to be more advantageous compared to using quantitative analysis during the Focus Group Discussions in

Site A and Site B. At the beginning of every session a participatory evaluation was performed with the participants of the FGD. Statements relating to health and hygiene were read out and the participants would rate a score from 1 to 5 on a piece of paper (based on their agreement or disagreement), which were then submitted anonymously for discussion. The example is as follows during an FGD in Site B with four participants (all women):

Statement: I always wash my hands with soap before I eat

- 1) I strongly disagree
- 2) I disagree
- 3) I do not know
- 4) I agree
- 5) I strongly agree

One person scored the number 5, two people gave a score of 4, one person scores a 2. The recapitulation of the answers can be seen in Figure 21.

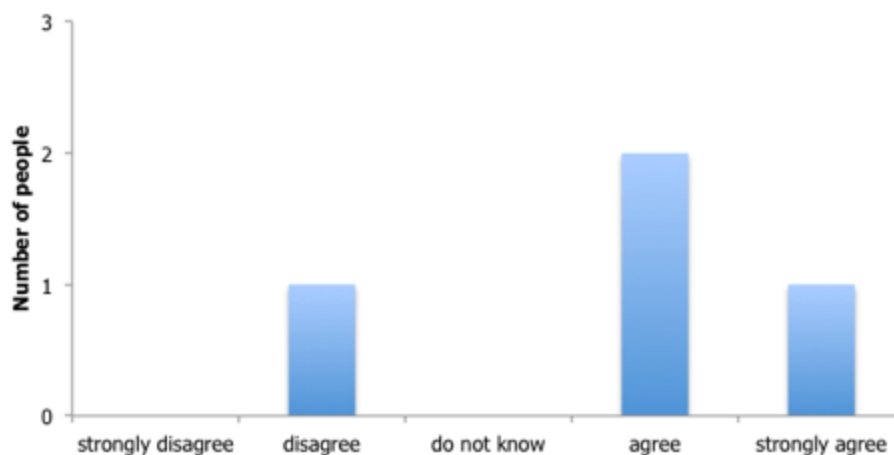


Figure 21 - Answers for the Statement: "I always wash my hands" in FGD of Site B

When the answers were gathered, the statement was further discussed among the group so as to give more explanations and examples during their daily activities. Through this discussion, it was found that over-reporting of good hygiene practices had occurred. Some of the users' voiced opinions differed from the grades that they had given initially. Similar findings of such behavior from participants (during surveys) were also seen in studies conducted in Burkina Faso and Bangladesh (Stanton et al., 1992, Curtis et al., 1993). The anonymity of the results were no longer present during the discussion, and the two people who admitted to always washing their hands with soap turned out that they will always do so *only* if there is soap present. If there is no soap within the vicinity, then they only wash their hands with water.

The participant who gave a score of 4 confirms that she agrees that people should always wash their hands with soap, but she herself only wash her hands occasionally with water. The remaining participant that gave a score of 2, indicating that she disagrees with the statement, was in fact stating her true behavior. She does not prefer to wash her hands with soap due to the slimy/foamy texture people have when washing their hands using soap, and she states that it would not be necessary to do so, as she eats with a spoon and fork (and not using her hands) It is a common practice in the Province of West Java to eat using the (right) hand (Gustiani, 2009).

The over-reporting was constantly occurring throughout the FGD, hence it was decided that the data would not be included in the report as it is misleading and do not represent the true

nature of the participants. Instead, the questions were used mainly as an ice-breaking method to open a subject of discussion with the women regarding hygiene and sanitation conditions in their area. The transcripts of the recorded discussions had been placed thematically and could be referred in Appendix 3.

5.3 Proposed design

5.3.1 Objectives

The objectives of this work is to create a design which fulfills the need of the user, reduce environmental pollution and protect the community from potential health hazards imposed by untreated black-water. Furthermore, the researcher aims to:

- Create a design with a user interface that is acceptable hence reducing re-intervention and reduce the risk of discontinuance.
- Create a toilet design using materials that are available locally and have been used within the vicinity of the area
- Create a design that promotes community participation at the decision making level (trial – adoption)

5.3.2 Background

During the preliminary phase of this work, the standard 'conventional' designs are removed and superseded to mirror the local 'helicopter toilets'. The aim of modifying the user interface is to move away from a general perceived user's needs that is integrated in a toilet design. Figure 22 documents the inside of one of the women's toilet cubicles in the faculty of CiTG TU Delft. The Figure 22 shows a common cubicle of a public toilet that can be found in many places in the Netherlands. Each cubicle has a lockable door, which allows the user to have complete privacy whilst defecating or urinating. Inside the toilet cubicle we will find tissue rolls for cleansing, toilet brush to clean the toilet bowl that has been soiled, and a sanitary disposal box to throw out objects that are not supposed to be flushed into the sewerage system.

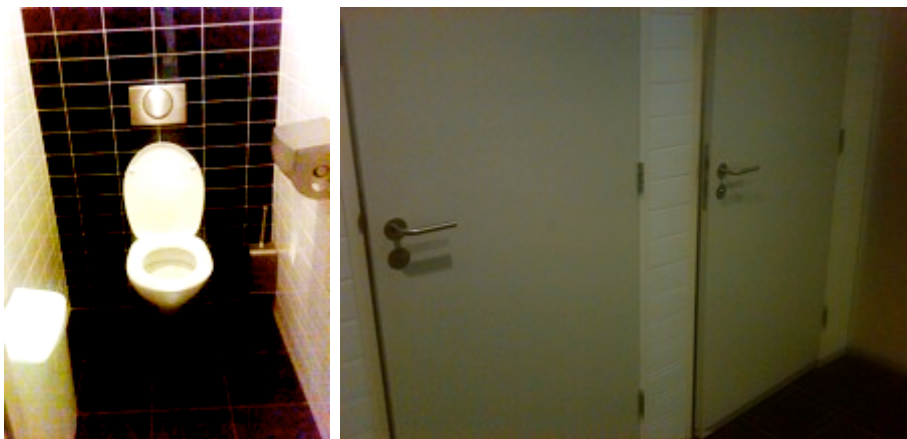


Figure 22 - Women's toilet in CiTG TU Delft

Observing the toilet shown in Figure 23, one could recognize almost a similar toilet as seen Figure 1 except for the additional water tap installed in the toilet bowl. The purpose is to aid 'washer' – users for anal cleansing after defecation. Figure 23 presents a toilet that is commonly seen in households, office buildings and shopping centers in Java. Other modification to enhance user's comfort level can be seen with the squatting pans. These were designed specifically for users that feel uncomfortable using seated toilet bowls; as they would be "sitting" skin-to-skin on the same spot as the other person. These type of toilets are abundant not only

Indonesia, but also in remaining South-East Asia countries, India and China (Avvannavar and Mani, 2008).



Figure 23 - TOTO toilet modified for 'washers'

Though many might doubt the reliability of the opened helicopter toilet, it presents benefits for its existing users. The short cubicles allow the flexibility of certain amount of privacy during defecation and still allow user to be exposed to the open air and not feel confined or constricted. In addition, the excreta immediately disappears and conveyed by the stream or flowing water in the case of Figure 24 without being seen by the user. This means that users do not have to be occupied with the hassle of flushing after they defecate.



Figure 24 - Helicopter toilets atop streams

The characteristics of the existing conventional toilet cubicles vis-à-vis the opened helicopter toilet are summarized in Table 11.

Table 11 - Comparisons between conventional toilets and helicopter toilets

Conventional Toilets (women)	Helicopter Toilets (unisex)
Complete privacy when defecating	Partial privacy during defecating
Flushing system that disposes excreta	No need to flush
Equipped with cleaning tools in case toilets get soiled	No visible traces of excrement
Sanitary disposal box to throw out sanitary napkins	Unconfined, exposed to open air

One of the underlying principles of this design is to learn from the existing facilities that have been made by the locals and incorporate the benefits of the helicopter toilet as presented in Table 11. The sight of the helicopter toilets to outsiders, may trigger sympathetic feelings to see an 'improper' facility to perform defecation. However, as the old proverb say, 'as an outsider, we only see what we know.' Instead of proposing a conventional toilet commonly found in a more developed area, the researcher believes that on-site observation provides an insight of the preferences of the local users. Such observations are important to help decipher the customary wants and needs of an area when direct structured interviews on the subject can be quite challenging.

The locals in the project area specifically built opened cubicles that did not have roof or enclosed at the top. This is contrary to the works recently conducted by the joint Masters project of the Industrial Design students in designing a toilet in rural Cambodia. Figure 25 and Figure 26 document the existing toilets made by the locals. It can be seen that the users clearly prioritized privacy, which was also confirmed through personal communication a member of the group.



Source: jointmasterproject.wix.com

Figure 25 - Toilet wrapped with cloth covering



Source: jointmasterproject.wix.com

Figure 26 - Enclosed toilet

Additional information that was taken into consideration for the design of this open toilet was the remark made by one of the housewives in the project area. The informant showed the wash area complete with a squatting toilet that was constructed in her home (See Section 2) but it is only used for guests and "outsiders" (referring to the researcher). Her family still prefers to perform open defecation in the fields as being confined within the brick walls "kind of hinders the desire to excrete." (Personal communication, May 2012).

Based on the information gathered from observations and personal communications with the locals, the researcher believes that an open toilet design is recommended for the project area. By creating a user interface that resembles existing system, it is hoped to minimize re-invention of the innovation and to avoid discontinuance due to unfamiliarity of the toilet facility by the users (Rogers, 1995). The design of the open toilet will be discussed in the following sections.

5.3.3 Data interpretation: gender segregation and privacy

"Oh, no thanks, I would rather wait until I get home", was the answer of one hesitant Indonesian student when asked why she did not go to the toilet. It was during the time when the communal toilet of the TU Delft central library needed to be repaired (May 2013), hence all male occupants were diverted to the female toilet. Aside from the additional line of people waiting outside the 7 cubicle in the girls' bathroom, of which a large portion was predominantly male, the sight was quite an unusual spectacle.

Whilst many take for granted the separated toilets based on gender, such facilities have been designed (formally) to fulfill the privacy needs of the users (Kitchin and Law, 2001, Kusumarini et al., 2012). The restrooms for both male and female are located away from the main traffic, in a space that hides from the crowd of library visitors hence reducing the embarrassment associated from being exposed to go to the toilet (ARA, 2006). Furthermore, the sex-segregated toilets were created to optimize the comforts of the users to perform the (private) rituals (of defecating and urinating) that have been compromised in a public space. The separate male and female restrooms provides unlimited access for both genders, without having the disruption and inconvenience of being in close proximity (during the private acts) with the opposite sex.

These benefits of having a gender-segregated toilet were not available in the past. In fact, according to Gershenson and Penner (2009), the luxury of having a separate toilet for women had only been acquired in the 1900's in The Great Britain. Unfortunately, nowadays similar inconveniences when using the public toilet are still felt among women in postcolonial countries, namely India, Tanzania and Ghana. Far distances, long waiting lines, restricted usage, competing with male occupants and unsafe locations (leading to violence) during night toilet visits are some of the issues faced by female users of the public toilets in developing countries (Fisher, 2006). One of the most recent tragedies occurred at the beginning of August in Calcutta, India, where an 11-year old girl was attacked at night when she was relieving herself outside her house (Gayle, 2013). By creating gender-separated toilets such issues will be resolved.

The application of gender-segregated toilets in Indonesia is quite varied. The Office buildings and shopping centers in the big cities as well as the recreational centers and education institutions have separate toilets for the men and women (Djamil, 2012). The KEPMENKES 1405/2002 had set the standard for office buildings to have separate toilets. Nevertheless, this standard has not been applied in all cases. BP4 Medan, a special hospital in the province of North Sumatera, owns unisex toilets (Sipahutar, 2012).

This does not comply with the KEPMENKES 1405/2002, however when comparing with the standards in Victoria, Australia and HSE of United Kingdom where unisex toilets in public spaces are permissible as long as the numbers of toilet visitors are <10 users for every toilet and that the toilets are lockable from the inside. Studies of open markets in Medan (Hendlyana and Naria, 2013) have segregated their toilets in accordance to KEPMENKES 519/2008, yet field observation in Bandung, West Java did not have similar toilet facilities. Furthermore, in the case studies, Site A, had two toilets with no sign for male and female. Unfortunately the toilets had not been used, hence it could not be deduced whether or not both toilets are interchangeably used as unisex toilets for the local community. On the other hand, the sanitation facility in Site

B had only one toilet with no gender signs, hence indicating that it is a unisex toilet that could be used by both male and female visitors. Furthermore, this is validated by the statements of the locals in Site B (see Appendix 3) that admitted themselves of using the facility as well as seeing mobile vendors (male) and motor bicycle drivers from outside the village (visitors) for using the toilet facility.

In respect to the project area, it could not be deducted clearly whether or not the segregated toilets based on genders would be a necessity (whether or not the community would have issues with unisex toilets) due to the fact that currently there is no communal toilet within the vicinity of the project area. Hence, limiting the research to gain insights of the community's receptivity in adopting a unisex toilet. In light of this, observations in the surrounding area with regards to the practice of relieving one self (open defecation in the field practiced by locals in the community or atop rivers in helicopter toilets, as practiced by the neighboring area) will be used to assess whether or not gender segregated toilets are required in the project area.

Evidence of a (cubicle) structure being used during open defecation can be seen in the numerous numerous helicopter toilets in the neighboring areas of the planned project area, including in Kampung Kampung Melayu Barat as seen in Figure 24. The community from the pilot project area also uses a structure, simply made up of four sheets of metal which forms a small cubicle, to relieve one self in the middle of the rice field (See

Figure 27).



Figure 27 - Metal cubicle in open field

Both the structures that were seen atop the streams and in the rice-field do not have signs that indicate whether or not it was for men or women. In the rice-field there was only one cubicle, which clearly indicates that it is a unisex cubicle and it can be used either by the men or the women of the community. The helicopter toilets in Figure 24 had two cubicles built side-by-side, however there were no signs that indicated if each cubicle was specifically designated for the men or for the women. Therefore, the locals could use both the cubicles interchangeably regardless of their gender, as seen during the field study.

Furthermore, it could be seen in Figure 24 and

Figure 27 that all the cubicles are semi-opened, allowing the top part of the users (in the cubicles) to be exposed to open air. This means that users; when relieving themselves in the cubicle, are visible to the passersby from outside or to the person using the next cubicle (in the case of the helicopter toilet).

The findings from the fieldwork (as mentioned above) contradicts the standard criteria for communal toilets in the public area as stated by the aforementioned Indonesian Regulations that require separated toilets for the men and the women. Further comparison with the Victorian standards; allowing interchangeable unisex toilets for male and female with the

requirement that the toilets are lockable from the inside, shows that such regulation differs from the preference of the locals. Findings of the field visit shows that the locals nearby the project area are relieving themselves openly (in the presence of another user and passerby), hence eliminating the need of a completely closed and locked toilet cubicle (in the design).

Nevertheless, it could not be deduced whether or not the women would feel comfortable to relieve themselves when the next toilet's occupants is from the opposite sex as such situation had not been observed. It is however observed that women were defecating in the helicopter toilets during day in the field study, hence differing from the findings in India (Fisher, 2006) where women had to wait until dusk to attain privacy when defecating.

As previously discussed, the majority of the local community of the pilot project practiced open defecation, defecation, either in the fields or atop gutters. Fisher (2006) shares examples where women had had difficulties to access public toilets (that were already present), hence they had to wait until dusk in dusk in order to go out in the field. On the contrary to the aforementioned findings, the women openly openly spoke and disclosed their habit of defecating in the open, even during day time in Kampung Kampung Melayu Timur RT 01 RW 01. Some also pointed at the cubicle seen in

Figure 27 as one of their preferred locations to defecate (Personal Communication, May 2012).

Several advantages of defecating in the field included anonymity. There had been evidence in India that India that women preferred to relieve themselves together in a collective, also to enhance security security (Agarwal and Majumdar, 2004). Although Indonesia is generally known as a collectivist (Hofstede (Hofstede and Hofstede, 2005), the local community in the pilot project area preferred to relieve relieve themselves (out in the open) individually. This is seen with

Figure 27, where there is only 1 cubicle, allowing 1 person to defecate each time, without the disturbance of other users within the vicinity.

This differed from the situation seen in Figure 24, the helicopter toilets in the neighboring village, Kampung Melayu Barat, that have two cubicles side-by-side, allowing two users to defecate/urinate at the same time. Furthermore, during the field study at the project area, the local women were asked about their opinion on the helicopter toilets that were available in Kampung Melayu Barat. They answered by saying how great it would be to chat the others whilst defecating. Nonetheless, the ladies laughed together when answering the question, which indicated sarcasm (Anolli et al., 2002). Unfortunately, there is no audio recordings of the discussions in the project area, hence the incident was only recorded as part of the written notes in the field study. By detecting the sarcasm of the statement, it is inferred that in fact the local women of the community do not prefer to defecate or urinate in the presence of others.

The findings of a singular cubicle in the rice field and the conversations with the local women, shows that the locals of Kampung Melayu Timur requires a (certain) level of privacy when relieving themselves.

The practice of open-defecation in the project area performed by the locals could not be immediately interpreted as the locals low preference on privacy (as they are comfortable relieving themselves out in the open). An issue was brought up by Mara (1996) stating that women feel embarrassed as they carry leaves (for anal cleansing after defecation), which reveals to the public that they are going to defecate or urinate. In fact; with the habit of performing anal cleansing at home and not the field (Frias, 2008), the locals possess anonymity when wanting to defecate out in the field as they do not carry anything (bottle of water, leaves, or toilet paper) that may indicate that they are going to relieve themselves. Furthermore, locals would walk outwards of the dwellings (personal communication, September 2012; to reach a place that is (well hidden) or covered from the public in the field. They also find it convenient to defecate and urinate on the gutters outside their home as it is nearby. Similar findings were seen in the case study of Site A (See Appendix 3) and studies conducted by Frias (2008) and Mungkasa (2008).

Thus in compiling the design criteria for an appropriate toilet facility that meets the users' expectations in terms of the gender and privacy the following are taken into considerations:

- 1) Completely enclosed space should be eliminated
- 2) Space should cover and provide (adequate) level of privacy when defecating
- 3) Side-by-side (semi-opened) cubicles are not preferred
- 4) Anonymity during the walk / path towards the toilet facility
- 5) Toilet facility is located away from the dwellings (locals are not exposed to the remaining of the residents when defecating)
- 6) Toilet facility should allow anal cleansing with water (currently locals are performing anal cleansing at home, after they defecate outside).

5.3.4 Schematic drawing

The top view of the toilet can be seen in **Error! Reference source not found.**Figure 28. This shows a toilet squatting pan and a bucket.

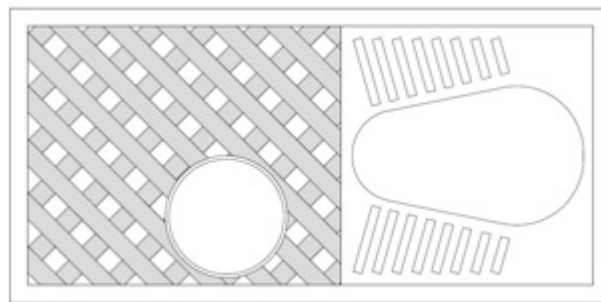


Figure 28 - The top view of the open toilet

The squatting pans materials can be selected from either ceramic or stainless steel. Both are considered durable, slip resistant and with the latter being resistant to rust. In terms of cost, the stainless steel pans are marketed (at least) twice the price of the ceramic pan, promoted with higher durability and low maintenance. The selection choice comes down to the preference of the users. These stainless steel pans have been highly recommended for installation in correctional facilities that are prone to vandalism. It prevents injury and promotes safety and eliminates possibility for costly damages. Bearing in mind that the squatting pan is not vulnerable to heavy-duty use in the projected area, the more affordable ceramic pans are recommended, unless the local users would like to be certain to avoid injuries (from cracking of the pans), which may cause injuries to the users. Again, the preference of the squatting pans can be restored to the hands of the target adopters.

The floor

The floor is made of wooden mesh, which allows rainfall to penetrate/ wash through the installation (during overflow or normal situation). This material is easily attainable locally. Similar material has been used to construct existing helicopter toilets as shown in Figure 24.

The cubicle

The enclosed cubicle can be made from a variety of materials. Presently, sheets of tin metal, as shown in shown in

Figure 27 and wood have been used as cubicles. In addition, bamboo mesh can also be used as the walls of the cubicle. All of these materials can be attained locally and have been used by the communities in the pilot project as sheds. There is no demand for strong super-structure, as the pan within the cubicle is already quite resistant. The main purpose of the cubicle is to provide (partial) enclosure for privacy during defecation.

The pour flush toilet pan

One of the unique criteria of the designed toilet cubicle is that it is outdoors with no coverings. Such design means that the toilet pan would be exposed to rainwater. The toilet should then be equipped with a system that prevents rainwater from entering the wastewater treatment unit. An S-neck water outflow connected to the squatting pan is used in order to create a water seal that would prevent odor coming through from the disposal unit. Overflow toilets (although only due to rainwater) is very unattractive. In order to resolve this issue, the doors would be equipped with an extended bottom sled which covers the toilet pan when the toilet is not being used (the door's position is that it opens inwards into the cubicle). The conduit can lead immediately into a septic tank, which is then followed by treatment with constructed wetland.

Water source

As previously mentioned, local communities defecate out in the open and go home to cleanse themselves using the water from their wells. Anal cleansing is very common among target adopters, and the task can be facilitated on site by providing a water source. This can be supplied through a standing pipe directly connected from the PDAM water service line or by harvesting rainwater by using a bucket placed in the cubicle (see Figure 7(a)). Although presently the communities are already conveniently cleaning after themselves at home, the present of a water source at the place toilet cubicles are necessary to flush the wastewater through to the disposal unit.

The combined system of a pour flush toilet with an cubicle that has been modified and customized to the local practices will be connected to a septic tank which is then flown into a subsurface constructed wetland (as the result from the technical assessment). Figure 29 represents the schematic drawing.

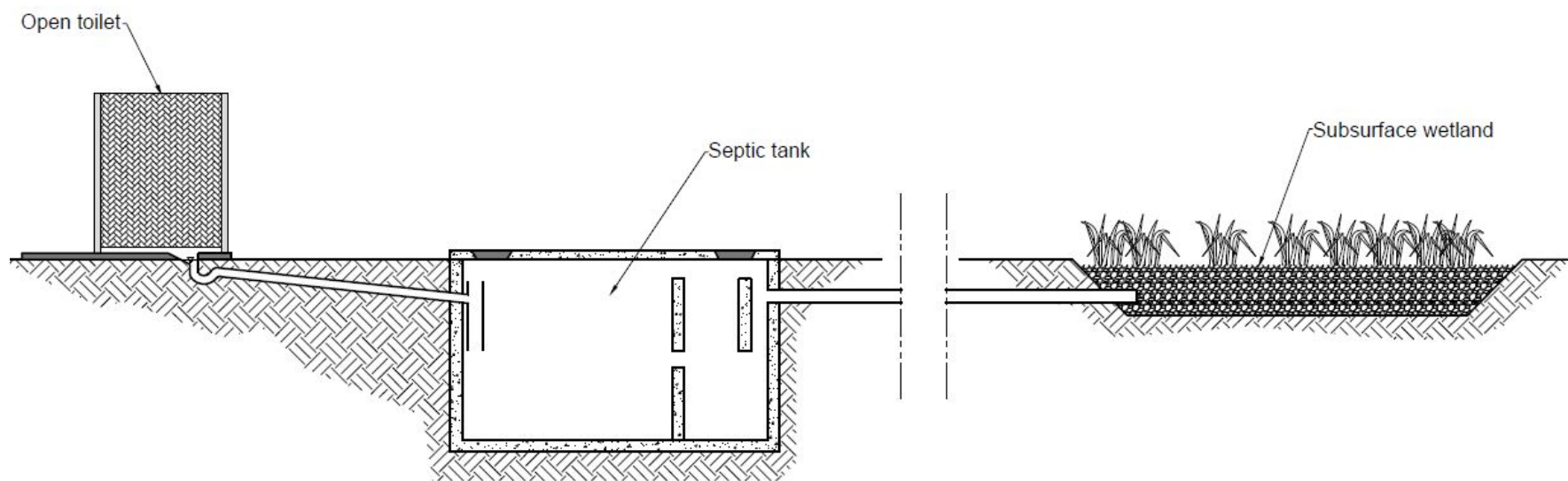


Figure 29 - Proposed sanitation option with septic tank and constructed wetland (subsurface flow)

6 Conclusions and Recommendations

The following are concluded from the technical evaluation of this research:

- The sanitation options that passed the screening phase according to the framework of Malekpour (2012) are:
 - Option 6, a pour flush toilet connected to a communal septic tank and a subsurface flow constructed wetland.
 - Option 10, a pour flush toilet connected to a communal septic tank and upflow filter.
 - Option 12, a the pour flush toilet connected to a and biogas digester.
- In the following evaluation phase Options 6, 10 and 12 performs roughly similar when assessed against the accessibility and the exposure to health hazards criteria.
- Option 6 performed best in the reliability criterion, followed by Option 12 and then closely followed by Option 10.
- In the sustainability criteria Option 12 performs best, followed by Option 10 and lastly by Option 6.
- The decision makers allocate their own preferences when weighing each criteria, (exposure to health hazards, accessibility, reliability and sustainability) hence Option 6 may not necessarily be rated as the best sanitation alternative (especially when the decision makers prioritize the sustainability of the system).

The following are concluded from studying the three study cases:

- A perceived need of the sanitation facility existed in Site A, however the majority of the locals were not using the facility.
- A perceived need of the sanitation facility did not exist in Site B, however the majority of the locals regularly used the facility for a short term (less than 2 years), but eventually reduce their usage due to the increasing number of in-house water connections to their homes.
- A perceived need of the sanitation facility existed in Site C and the majority of the users rely on the *MCK* facility in Site B.
- The findings of this research supports the hypothesis whereby conventional sanitation reforms do not fit the need of the local users.
- The incoherence between the existing perceived need of the direct users and the usability of the *MCK* facility indicates that there are other (intervening) factors such as the maintainability of the facility, its affordability, water accessibility as well as the level of convenience offered.
- Those intervening factors are a manifestation of the users' expectations on the sanitation reform. When these expectations are not met users become less inclined to use the sanitation facility.

Based on the study of this research, the following recommendations are proposed:

- An integrated social-technical-economic feasibility study is vital prior to the commencement of a (development) project. Although, it is less attractive to invest on the 'software' compared to the (vivid) and visible physical 'hardwares'; Decision makers should put considerable efforts in deciphering and or defining key problems or issues within the area. Projects where the goals have been pre-defined goals may or may not coincide with the needs of the target adopters.
- To ensure the fulfillment of the direct users' needs (thus to also guarantee optimal utilization of the sanitation reform), it is vital before beginning any sanitation projects to hold public communication activities. This include public hearing, local gatherings, and focus discussion groups
- The difference between the social background of the researcher and the respondents (target adopters at the area of study) should not be undermined as it could result in poor interpretations (gestures, intonation and other communication habit during interviews and discussions) of the collected information

- In a collectivist community, such as in Indonesia, it is important for researchers should introduce, and make themselves known by actively being present in the surrounding community to gain the local's trust. Researchers should involve themselves in social activities also and not only on data collecting activities.

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APPENDIX 1

Table 1

Criteria	Required Data
Exposure to health hazards	<i>If water supply is from a local well without treatment:</i>
	Soil properties (hydraulic conductivity, porosity)
	Thickness of the unsaturated zone
	Depth of the well screen
	Discharge rate and radius of the well
	Lateral distance between the well and the sanitation disposal location
	Hydraulic loading rate from the sanitation facilities
	In case of using WhAEM geohydrological model for capture zone estimation, binary base map of the underserved area
	Areal recharge rate
	<i>For all cases:</i>
	Degree of microbial attenuation in faecal matter prior to exposure of waste workers (which is dependent on the storage time of faeces and the storage environment)
Accessibility	<i>If shared sanitation facilities are going to be applied:</i>
	Location of the toilet facilities
	Distance of the houses to the toilet facilities
	<i>If toilet products are going to be reused directly:</i>
	Identification of reuse centres
	Percentage of the recovered products that is demanded in reuse centres
	Location of the reuse centres and their distance to the sanitation facilities
Reliability	Availability of logistics and transportation facilities for transferring the toilet products to reuse centres
	Routine hours of water supply (if there is a routine timing)
	Average rate of water supply failure (if there is no routine timing and water supply failure is a random event)
	List of possible incorrect uses of sanitation facilities by users
	Monitoring data on the number of incorrect uses of sanitation facilities that occur in the most available similar socio-cultural environment where the sanitation facilities were implemented previously
	List of the required O&M tasks for sanitation facilities and the required tools and equipment
	Repair time data for sanitation facilities based on local conditions (from which average repair time and the standard deviation would be derived)
	Annual O&M costs (based on local cost of tools and equipment, number of people for O&M activities, corrective and preventive maintenance time, mean time between failures, local labour hour costs)
	Identification of financial resources for O&M activities, their contribution and their stability over a length of time

Sustainability	Flood depth data over several years
	People's memory on flood depths if no recorded flood depth data is available
	Construction level of sanitation facilities on the ground
	Population growth rate
	Prospective water supply coverage and flows (derived from the existing coverage trend for the location and water supply budget allocation for the considered location)
	Prospective wastewater flows resulted from population growth and/or water supply coverage

Table 2

PARAMETER	UNIT	CLASS II PP 82/2001	Anna Well	Sim Subur Well	Benyo Well	Yanti Well	River
Temperature	Celcius	air temperature $\pm 3^{\circ}\text{C}$	27,4	27,3	27,3	27,2	27,1
Color	PtCo	50	0	22	1	4	20
Turbidity	NTU	25	9,08	3,26	3,98	14,90	11,70
TDS	mg/l	1000	529	442	530	589	100
Electrical conductivity	$\mu\text{S}/\text{cm}$	-	1076	904	1078	1196	1022
Salinity	‰	-	0,5	0,4	0,4	0,6	0,1
pH	-	6,5 - 9,0	6,53	6,49	6,65	6,64	6,71
Dissolved oxygen	mg/l	≥ 4	3,23	1,29	2,45	1,68	4,61
COD	mg/l	25	26,9	26,4	18,2	26,5	-
BOD	mg/l	3	11	-	10	-	-
Organic compounds	mg/l	10	18,32	29,20	12,35	17,78	14,60
Ammonia	mg/l	-	0,03	0,44	0,07	0,34	0,23
Phosphate	mg/l	0,2	0,40	0,37	0,26	0,54	0,29
Nitrate (as N)	mg/l	10,0	2,9	2,8	3,3	2,6	6,3
Nitrite (as N)	mg/l	0,1	0,068	0,043	0,037	0,033	0,049
Sulphate	mg/l	-	34	27	51	46	26
Cyanide	mg/l	0,02	0,006	0,015	0,009	0,007	0,020
Fecal Coliform	Colony/100 ml	1000	135	39	0	32	66
Total Coliform	Colony/100 ml	5000	350	74	0	148	140

Table 3

Score				
low	1	1	1	1
medium	2	5	10	50
high	3	10	20	100
Option 6	19	201	801	2001
Option 10	18	200	800	2000
Option 12	18	200	800	2000

Table 4

Treatment	Activity	Lump sum price (IDR)	Materials and tools (IDR)	Time labor (h)	Frequency (/annum)	Yearly cost (IDR)
Septic Tank + upflow filter	Empty the septic tank	250000	250000		1	250000
	Empty the upflow filter	250000	250000		1	250000
	Replacing the filter media	500000	500000		1	500000
TOTAL						1000000
Septic Tank	Empty the septic tank	250000	250000		1	250000
TOTAL						250000
Biogas Digester	Weekly maintenance of biogas digester (cleaning gas appliance, lubricating movable parts, maintenance of pressure valves and slurry mixer, and controlling gas appliances and fittings)	780000	10000	1	52	780000
	Check the plant in respect of corrosion and, if necessary, renew protective coating material	100000	90000	2	1	100000
	Check the gas pipes for gas tightness (pressure check). If necessary, search the leakage and repair the parts concerned. Note: minor gas leakage is usually undetected during normal operation as it is 'compensated' by gas production	100000	100000		1	100000
TOTAL						980000
Constructed Wetland	Structure inspection to ensure to ensure the inlet, outlet and weir are free from blockage and not damaged			1	4	20000
	Wetland inspection, monitor plant condition, weeds and litter removal		96250	1	4	405000
TOTAL						425000

APPENDIX 2

Communal Septic Tank

Septic tank design requires a minimum of a 1 day retention time. The number of users is 488 people (the population projected in 20 years) discharging wastewater (blackwater) at a rate of 20 l/ca/d.

$$V1 = Q \times N \times t$$

$$V2 = Q_c \times Y \times N$$

$$V_{\text{total}} = V1 + V2$$

Where,

Q = wastewater discharge per capita (l/ca/d)

N = number of people served

t = residence time (1 d)

Q_c = Q

Y = years between cleanings

$$V1 = 488 \times 20 \text{ l/ca/day} \times 1 \text{ day} = 9.8 \text{ m}^3$$

$$V2 = 20 \text{ L/ca/d} \times 1 \text{ year} \times 488 = 9.8 \text{ m}^3$$

$$\text{Total} = 19.6 \text{ m}^3 \approx 20 \text{ m}^3$$

Assuming the height of the septic tank is 2 m, then the area of the septic tank is 10 m².

Constructed wetland

K_T : BOD₅ decay rate at temperature, T

K_{20} : BOD₅ decay rate at 20°C

T : the minimum ambient temperature in Teluk Naga in (°C)

$$K_T = K_{20} \times (1.1)^{T-20}$$

$$K_T = 0.86 \times (1.1)^{(30-20)}$$

$$K_T = 2.23$$

t : the hydraulic detention time (days)

C_e : the desired effluent BOD₅ concentration (12 mg/L)

C_0 : the influent BOD₅ concentration (200 mg/L)

$$t = - \frac{\ln \frac{C_e}{C_0}}{K_T}$$

$$t = - \frac{\ln \frac{12}{200}}{2.23}$$

$$t = 1.26 \text{ days}$$

A_c : the cross-sectional area of the wetland, i.e., width x depth (m²)

Q : wastewater flow rate in (m³/d)

K_j : the permeability of the media in m³/m²-d

S : the slope of the wetland

$$A_c = \frac{Q}{K_j \times S}$$

$$A_c = \frac{10}{500 \times \frac{1}{100}}$$

$$A_c = 2 \text{ m}^2$$

W : the width of the wetland (m)

d : the depth of the wetland (m)

$$W = \frac{A_c}{d}$$

$$W = \frac{2}{0.3}$$

$$W = 6.67 \text{ m}$$

L : the length of the wetland (m)

Q : the wastewater flow rate (10 m³/d)

n : the porosity of the media

$$L = \frac{t \times Q}{A_c \times n}$$

$$L = \frac{1.26 \times 10}{2 \times 0.35}$$

$$L = 18 \text{ m}$$

$$\text{Area} = L \times 2 = 36 \text{ m}^2$$

Biogas Digester

The expected gas yield can be estimated as follows:

0.5 kg faeces (14% organic dry substance, ODS)	= 70 gr ODS/person
1.0 l urine (2% ODS)	= 20 gr ODS/person
Total	= 90 gr ODS/person

1 kg ODS produces approx. 450 litres biogas

90 gr ODS/person x 488 person = 43.9 kg ODS

43,9 kg ODS x 450 l/kg = 19.8 m³ biogas/day

(approx. 19800 litres biogas per day)

$$V_{\text{digester}} = \frac{\text{biogas produced} \times 60\%}{0.24} = \frac{19,8 \times 60\%}{0.24} = 50 \text{ m}^3$$

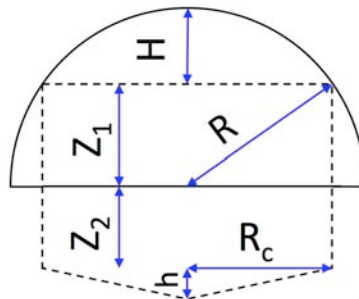


Figure 1 – Dimensioning fixed dome digester with suspended gas holder

$$R = \sqrt[3]{(0.45 \times V_{\text{digester}})} = \sqrt[3]{(0.45 \times 50)} = 2.8 \text{ m}$$

The radius of the digester, R , is 2.8m. Therefore the area of the digester is 24.6 m², as seen below:

$$\text{Area digester} = \pi \times R^2 = \pi \times 2.8^2 = 24.6 \text{ m}^2$$

In order to calculate Z_1 , H is subtracted from the spherical radius R , whereby H is equivalent to 0.47 R .

$$Z_1 = R - H = R - 0.47 R = 2.8 \text{ m} - 1.3 \text{ m} = 1.5 \text{ m}$$

The radius of the cylinder, R_c , can be determined through the rule of Pythagoras, using the known values of Z_1 and R as presented in Equation 28.

$$R_c = \sqrt{R^2 - Z_1^2} = \sqrt{(2.8^2 - 1.5^2)} = 2.4 \text{ m}$$

The next phase is to determine the area of the compensating tank. The volume of a compensating tank is equivalent to the volume of the gas holder.

$$V_{gh} = \pi \cdot R \cdot [H^2 - (0.2R)^2] + [(0.2R)^3 - H^3]$$

Where,

V_{gh} = Volume of gas holder (m^3)

$$V_{gh} = \pi \cdot 2.8 \cdot [1.3^2 - (0.2 \times 2.8)^2] + [(0.2 \times 2.8)^3 - 1.3^3] = 10.1 \text{ m}^3$$

The volume of the compensating tank is equivalent to the volume of the gas holder, which is 10.1 m^3 . The height of the compensating tank, h_{ct} , can be calculated as follows:

$$h_{ct} = p - H - 0.2R = 0.73R - 0.47R + 0.2R = 0.46R = 0.46 \times 2.8 \text{ m} = 1.3 \text{ m}$$

The area of the compensating tank is obtained through dividing the volume of the compensating tank (10.1 m^3) by the height of the tank, h_{ct} , as shown in the calculations below.

$$A_{ct} = \frac{V_{ct}}{h_{ct}} = \frac{10.1 \text{ m}^3}{1.3 \text{ m}} = 7.8 \text{ m}^2$$

Where,

A_{ct} = Surface area of the compensating tank (m^2)

V_{ct} = Volume of compensating tank (m^3)

$$\text{Total area} = \text{area digester} + \text{area compensating tank} = 24.6 + 7.8 = 32.4 \text{ m}^2$$

APPENDIX 3

Table 1

Topic	Site A	Site B (<i>Kotamadya</i>)
Expenditures	<p>"The expenditures far exceed the household income right?" Informant AA, September 2012</p> <p>"Indeed (the income is less than the spending). What's the monthly expenditure?... Well, our debts are bigger. [...] We manage our household finances, don't expect our men to bother about it. [...] Without including our debt, then (our daily spending) is not so much ma'am, maybe around (IDR) 30000. [...] And then there's the payment for the school, snacks, not to mention the debts. [...] There has never been a time when there was no street food vendors here. " Informant AD, September 2012</p> <p>"(My expenditure) Is uncountable ma'am, too much debt. [...] If I count our debt also, it's (IDR) 20000 so it becomes (IDR) 60000 (per day). [...] You can imagine (the money) kids spend on snacking nowadays. [...] Also considering the school fee, daily allowance money (for kids)." Informant AT, September 2012</p> <p>"Counting the meals and snacks bought outside would probable be between (IDR) 30 to 35 (thousand). " Informant AR, September 2012</p> <p>"My husband gives the money, even if sometimes it's only 10000 then he doesn't care (how to spend it). [...] For me (the daily expenditure) it's (IDR) 20000. Yes, around (IDR) 20 (thousand) to (IDR) 25 (thousand). [...] Also setting aside the school fee and other things." Informant AI, September 2012</p> <p>"Mine (daily expenditure) is roughly (IDR) 25000." Informant AN, September 2012</p>	<ul style="list-style-type: none"> It is difficult to get the children not to buy food from outside. Even if we provide them with packed lunch, they will finish that and still buy from outside. It's expensive to cook at home and having to buy all the ingredients. <p>"[...] Maybe if there's a small cooperative or credit union, perhaps it could help (our situation). [...] If not perhaps we could have some activities, so we could at least have a weekly income. You know, maybe some handcrafts, weaving perhaps... [...] The mothers could have some tasks (chores/work)." Informant BA, September 2012</p> <p>"[...] Yes, before we could save our money (in a cooperative union)." Informant BB, September 2012</p> <p>"[...] There used to be one (a community cooperative) but it doesn't exist anymore." Informant BC, September 2012</p> <p>"[...] Yes, there was one (a cooperative) before. [...] We used to have some handcrafts, making shoe-boxes, I think it was around IDR 25 (000) right per box?" Informant BD, September 2012</p>

Table 2

Topic	Site A	Site B (Kotamadya)
Food hygiene	<p>"<i>Alhamdulillah</i>, the groundwater... is already healthy. It had been analyzed before because some (locals) had contracted <i>muntaber</i> (acute diarrhea and vomiting), and it was actually not from there, not from the water. But instead it came from the food. [...] It's difficult to break the habit, the locals here like to buy ready-made food from outside instead of cooking at home. [...] In our area there's food vendors available from morning to night, from the moment we open our eyes until the time that we close them... then people would stop (snacking). [...] You see... that's why (it's ironic)... The majority of the community is categorized as low income families, but the amount they spend to buy food from outside is a lot. [...] (IDR) 4000 for a meal each time you buy outside, that's around the same amount (spent) for cooking home meals. "</p> <p>Informant AA, September 2012</p> <p>"For example my son is already big, he runs around a lot. If I see (him) eating something dirty, then I take it (from him). If not, well... [...] Seldom cook (at home), mostly we buy food from outside, so that's around (IDR) 4000 for a meal, seriously. [...] (The children) don't eat the packed meals we've prepared for them. They don't even drink the water they take from home. [...] Children are fussy with food. When we pack them meals, they bring it home (untouched) and buy something else outside. [...] We pack them a bottle of water, and they buy an icy drinks from outside. [...] My son would not head out to school when I only gave him (IDR) 2000. [...] They (the children) seldom eat (again) at home because they have consumed snacks. But later in the afternoon they would ask for a meal. [...] We don't really have a proper meal the day, maybe we'd buy a dish of meatballs for our (late) lunch or dinner. [...] It's not only the kids that like to snack, but the mothers too, right ma'am? [...] In the evenings we would also buy from outside. [...] At home it is not possible to cook in small amounts you see, because we are joint together (living in the house of the in-laws), so (to make) the meal costs more than (IDR) 20000. That's why we buy food from outside. [...] You see, we cook when we have money, then we would do so. If we don't have money, my oh my... I don't know, we'd get food from outside... Probably we'd just buy meatballs. [...] Even when we were living separately (from the in-laws), it is still the same for me, I don't cook in small amounts... Maybe if I cook noodles then it would not be much."</p> <p>Informant AD, September 2012</p> <p>"Unless we see... (the child putting things in their mouth), then we'd take it. [...] (Normally) A (pack) of noodles (shared) for three people with an egg right? [...] If we pack them meals from home, they (the children) don't eat it. [...] Sometimes the food we've prepared from home are shared (with other students) at school. [...] They don't want to go to school if we do not give them allowance money. [...] Still... Even though they eat at home before leaving for school, by the time they</p>	<p>I believe that it is important to lead a healthy and hygienic lifestyle. Score: 5,5,5,5 (Agree) FGD, September 2012</p> <p>"Well, yes I cook when there's you know, the money. If there isn't any then that's it. [...] No (dinner) preparation. Well, maybe, some noodles... It depends. [...] You see, if I, for example had IDR 10000, and there's no rice at home. So I'd give it for my kids to snack. And I? I just stay at home. I don't have the money to buy anything... So I stay inside the entire day. [...] I mean, I can hold my hunger, but the kids? [...] If there was money, then we could eat at home, for example we could bake a cake or <i>martabak</i> (thick pancake). You see, when we don't have (enough) money, the children will just buy snacks outside. They buy whatever they want and we don't see it, we don't know. Afterwards, they come back all cheered up."</p> <p>Informant BA, September 2012</p> <p>"Yes, I cook. [...] Buy eggs. [...] Well, I'd cook up some noodles with eggs.[...] Yes, even though I cook at home, still, one of the children doesn't want to eat home-cooked meals, the other wants another thing. They have different wants from one to the other, so it becomes irritating. "</p> <p>Informant BB, September 2012</p> <p>"Well, sometimes I ask my child what he snacked on at school. So I would know. [...] I buy eggs, even though we only have rice (at home). [...] I cook rice at home, and sometimes I make fried rice for breakfast. [...] Yes, also fried rice with eggs. [...] Sometimes we already prepare a meal at home. But they're just kids you know, and they don't get it. They would still go outside and snack, wanting this and that."</p> <p>Informant BC, September 2012</p> <p>"Yes, I get some eggs. [...] No, I don't really (prepare dinner)... Usually, my husband have already dined beforehand. [...] I mean in my family, my husband always gets his own meals. I never you know... So, he would give say IDR 25000 for a single day, and that money is for me and our child. So he finds and buys his own food separately. [...] So, I would probably buy rice and cook it (at home), mostly I buy the cooked meals from the vendors for my child. [...] It's pretty inconvenient if I had to prepare my meals all by myself and not have the necessary ingredients. [...] The difficult part is not having the seasonings and cooking oil right? I mean, if I had all the seasonings, rice and cooking oil, then (IDR) 25 (000) would be sufficient to go to and buy (additional ingredients) from the stalls. Most likely I would only need to spend around IDR 15000 at the small</p>

	<p>reach there, they would buy some snacks to nibble. [...] When they're at home and they're thirsty, I point at our water jug, and they would say 'No... that's different. [...] At school we would mostly see the mothers buying the meals from the vendors. [...] Well, mostly because my child doesn't like it, maybe chicken's feet... We rarely eat red meat or chicken. [...] I'd buy a meal for around (IDR) 4000, and sometimes (we eat it) together with my kid. [...] We also have to buy the cooking oil."</p> <p>Informant AT, September 2012</p> <p>"We let them (the children) be... It's difficult [...] If we are there, we see them, then we take it out (from their mouth), but if not then we let it be. [...] It is very common for kids to buy snacks and drinks from food stalls or street vendors. [...] When we're already very hungry then we would eat. [...] Some of the mothers would take the children to school, and then they would also buy snacks. [...] No ma'am, we have red meat around once a month. "</p> <p>Informant AR, September 2012</p> <p>"We let them eat whatever they want. [...] (We) don't take the kids to school that often, so we don't know what they buy and snack. [...] Sometimes it (the food sold by the vendors) makes us more hungry (when we aren't). [...] Well, my husband always eat out at night so there's no need (to prepare dinner at home). [...] If you think about it, how much does a liter of rice cost? IDR 7500. That's the kid's allowance money already."</p> <p>Informant AI, September 2012</p>	<p>shop. [...] If I don't give allowance to my child, she will throw a tantrum and start hitting me. "</p> <p>Informant BD, September 2012</p>
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Table 3

Topic	Site A	Site B (<i>Kotamadya</i>)
The importance of hand-washing with soap	<p>5, 4, 3, 2, 2 (before eating) 5, 4, 5, 5 (after excreting) FGD, September 2012</p> <p>"Perhaps, from the parents you see... are not used to disciplining (their) children to wash their hands before they eat. So parents... it is important that they implement the <i>PHBS</i> (Healthy and Hygienic Lifestyle) to their children [...] So, it is the case here that the locals are still not used to washing their hands (properly) with soap [...] Different (hand-washing with or without soap). It is much cleaner with soap [...] The water should not be stagnant, it would be better if it was flowing water to wash hands."</p> <p>"[...] If (the locals) are bathing, they bring soap (to also cleanse after excreting), if not then..."</p> <p>Informant AA, September 2012</p>	<p>Score: 2,4,5,5 (before eating) FGD, September 2012</p> <p>"We always tell our children to wash their hands. But the kids tend to play and run off by themselves. [...] Before anything, we'd tell them to wash their hands, and they would reply 'Ugh, washing our hands (for what)? We're going using our spoon.' You see... But, I always remind them to wash their hands."</p> <p>Informant BA, September 2012</p> <p>"There's always soap in our bathroom. [...] You know how kids are right? Out in the field they'd be playing with sand, soil, whatever is around."</p> <p>Informant BB, September 2012</p> <p>"There's always soap around. [...] At least when we go out at least we'd always wash our hands with water. [...] At times, the children already understand..."</p>

	<p>"So, actually... we want practicality you see miss [...] It is seldom done miss. It is not possible to do it all the time you see [...] If before eating than it is rarely done, especially for those that don't have a bathroom (at home) [...] It is difficult to do it 100% all the time. So well... we simply do it adequately, at least we wash... wash... (our hands) and they are wet. [...] Different (hand-washing with or without soap) [...] You see, when we wash our hands normally (without soap), the dirt gets removed, but not necessarily the bacteria.</p> <p>[...] (after defecating) We bring soap...our own soap (to wash hands after defecating near the river). We bring it along when we head down (to the river) to wash ourselves [...] When there's no soap, we just borrow the from the others (nearby). We cleanse ourselves (once) near by the river, and then we it's cleaner at the washroom (by the river) [...] If we cleanse ourselves using the water from the stream, if done continuously, then it becomes itchy... it's dirty... But that's hardly every the case, it'll be wiped off."</p> <p>Informant AD, September 2012</p> <p>"If we were already hungry, then we eat (immediately). Maybe we'd wash our hands after we cleanse ourselves (after excreting) [...] It is different (hand-washing with or without soap) [...] It is cleaner to wash our hands with soap, when we only use water it is only done inadequately. So long as the dirt gets removed."</p> <p>Informant AT, September 2012</p> <p>"Of course, I always, always do it..." (sarcastic, followed by laughter) [...] (It is rarely done) Especially if there is no soap in the washroom, then that's it [...] When (should we wash our hands with soap)? It's normally after we eat with <i>sambal</i> (spicy Indonesian chilly mix). [...] (It is) different (hand-washing with or without soap) [...]</p> <p>[...] It's itchy if we don't cleanse after excreting.</p> <p>Informant AR, September 2012</p> <p>"When we use a spoon, then why should we? [...] If it is very-very dirty then I wash my hands with soap [...] Depends... on what (the hands) it was used for[...] It is very far (to the stream) to wash our hands [...] (In stagnant water, the bacteria) it circulates in the water</p> <p>[...] (after defecating) We bring our own soap (to wash hands after defecating near the river)."</p> <p>Informant AI, September 2012</p>	<p>(they'd say) 'Mom, I should wash my hands first'. [...] It is not only after every meal, we'd always remind the children to wash their hands. We tell them. "</p> <p>Informant BC, September 2012</p> <p>"If we're going to eat using our hands, then we'd wash our hands before that. But, my daughter doesn't want to eat with her hands. She eats with a spoon... So she hardly uses her hands, she's simply not used to it. [...] Later, when she's eating and she gets the rice sticking (onto her fingers), usually she'd have two mouthfuls and she'd say 'It's sticky...', then she would wash her hands."</p> <p>Informant BD, September 2012</p>
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Table 4

Topic	Site A	Site B (<i>Kotamadya</i>)
Location of excrement	<p>"Most people here don't have private toilets [...] It is already a habit (to head down to rivers or sit on top of ditches to excrete)."</p> <p>Informant AA, September 2012</p> <p>"I go to the big stream... [...] Well, excuse us miss, you see we don't have private toilets here. So we just squat (wherever). [...] (slippery grounds) it's risky... a risk we take [...] We are used to it. There aren't toilets (at people's homes) here. [...] Sometimes when we go to the big stream we bring buckets... get water... to be prepared at home. So, we don't always have to go to the stream all the time. [...] (When needing to go in the middle of the night) Then we just do it there [...] Find (a place to excrete) wherever is nearby [...] The rented flats don't have their own toilets, so they go to the front... the gutters (to excrete). That's true right? Compared to holding it back, it's for our own health right ma'am AA?... We have a small hole... [...] (Mrs. AD) when she needs to go, simply walks to the toilet. But us... when we really have to go (and defecate) we need to run [...] If it is at night, then we'd head down to the river... Wake our husband and ask to be accompanied [...] Perhaps if urinating, then we'd go nearby... [...] We are fine with the way it is now (heading down to the river or atop gutters to defecate), we are used to it... It's been this way for a long time. Well, we don't have the facility, If there was, then perhaps we wouldn't have to be doing what we are doing now right ma'am? [...] It is closer to go to the river (than to the MCK facility). [...] Now there are no more sheets of metal (tin) or sacks, so we just squat there (under the bridge). [...] Before, those sacks would cover us (while defecating), but it is no longer useful because the water level often changes."</p> <p>Informant AD, September 2012</p> <p>"I go to the MCK (facility). There's a lot of workers (at the river) so I'm embarrassed, that's why I go to the MCK (facility). [...] There's a small ditch in front of the house... the toilet. So, when my child wants to go, simply go outside and defecate in the hole [...] Mrs. AR has a (private) toilet at home, she doesn't have to be inconvenienced by this. So, there's no hassle."</p> <p>Informant AT, September 2012</p> <p>"(Defecating outside)... That's filthy, I can't imagine. [...] You are (all) welcomed (to use the toilet) at my home, then pay (IDR) 1000, each time."</p> <p>Informant AR, September 2012</p> <p>"Big stream. But if there's water at the MCK facility, I go there, but when there's none, then we're forced to do it next to the river [...] right under the bridge [...] (When needing to go in the middle of the night) We just hold it until the morning... we just hold it [...] Well, AR has a toilet, but I'd have to go to someone else's place [...] If (I) can't take it anymore, then I'm forced to go outside... anywhere close [...] As if we would (dare) knock on Mrs. AA's door at 02.00 am in the morning to ask (and use the toilet). If it's late at night, then we'd have to go to the river [...] I'm used to it."</p> <p>Informant AI, September 2012</p>	<p>At home. The locals in the area own private toilets.</p> <p>"I do it (defecate) at home. You see, it is not that crowded in my place."</p> <p>Informant BC, September 2012</p>

Table 5

Topic	Site A	Site B (Kotamadya)	Site C (Kabupaten)
The advantages and disadvantages of the current sanitation facility	<p>"It's actually not because there's no water supply. There is water (available), but the ones that go to the streams, cannot be bothered to let out the water (to fill the wash basin) you see. [...] There is electricity (and lighting) there (at the MCK facility)"</p> <p>Informant AA, September 2012</p> <p>"Sometimes there's hardly any water (at the MCK facility), especially after noon. It goes on and off. [...] We would like to do it (excrete) in a bathroom. But then we go there in the afternoon and see that there's no water, so we head back (out from the MCK facility). And then in the evening, once (I) went there with my husband... it was dark, there was no lighting... and also no water. <i>Ih...</i> then we head back out. We don't know why (it's like that), perhaps because there is no caretaker, well we don't know ma'am. [...]"</p> <p>Informant AD, September 2012</p> <p>"The MCK facility here, you see ma'am, is not being used because it is rather far. Maybe the one under the bridge is more convenient."</p> <p>Informant AT, September 2012</p> <p>"Well, you only get water sometimes..."</p> <p>Informant AI, September 2012</p>	<p>"It's not that it is not clean enough, but it's just troublesome. Like... if we were just doing our business and pooping, then someone would be knocking (on the toilet door) 'knock...knock...knock...'. We were interrupted, well then it (the feces) was suppose to come out, but then it breaks you see."</p> <p>Informant BA, September 2012</p> <p>"It (the MCK facility) is pretty useful. [...] You see, some people from C, some motorbike drivers don't necessarily have toilets (at home) because they rent their place and so they would all come running to the MCK (facility). Showering... defecating... they would do it all there at the MCK facility. [...] It doesn't feel comfortable (being interrupted whilst defecating)."</p> <p>Informant BB, September 2012</p> <p>"Sometimes the street vendors would use it (the MCK facility) or people use it when there's a lot of guests."</p> <p>Informant BC, September 2012</p>	<ul style="list-style-type: none"> Provides as an alternative washroom when it's crowded (with large families) at home. Plenty of water, unlimited use.

Table 6

Topic	Site A	Site B (Kotamadya)	Site C (Kabupaten)
Does the facility fulfill the current need of the users? / The usability of the facility	<p>Scores: 1, 2, 2, 2, 5, 5</p> <p>FGD, September 2012</p> <p>"Those that have private toilets don't use it (the MCK facility). AD always go there (to the MCK facility)"</p> <p>Informant AA, September 2012</p> <p>"Very rarely... [...] It can be said that almost everyone</p>	<p>"No, I don't use it (the MCK facility), maybe sometimes when I need to wash my hands."</p> <p>Informant BA, September 2012</p> <p>"Of course BC uses the toilet at (her) home. There's no need (to wait in line) when there's only 3 people (in the house) right?"</p> <p>Informant BB, September 2012</p>	<p>Score: 5</p> <p>Informant CB, September 2012.</p> <p>Score: 5</p> <p>Informant CA, September 2012.</p>

	<p>needs an MCK. But people seldom go there (to the MCK facility). [...] Occasionally... because, well ma'am sometimes we also need it (to go to the MCK facility), it's not always a 'No' you see. [...] If we say we need (the MCK facility) but we hardly use it (the MCK facility), but if we were to say no (need), we do go there (and use the MCK facility)."</p> <p>Informant AD, September 2012</p> <p>"I use it at times. [...] I go to the MCK facility quite a lot actually, that's why I scored it at 4."</p> <p>Informant AT, September 2012</p> <p>"We hardly go there... [...] But this one (AT) goes there a lot. "</p> <p>Informant AR, September 2012</p> <p>"That (rare) is once in an entire year. [...] We rarely use it (the MCK facility)."</p> <p>Informant AI, September 2012</p>	<p>"No, I don't (use the toilet). I only wash (at the MCK facility)."</p> <p>Informant BC, September 2012</p> <p>"I don't use the toilet (at the MCK facility)."</p> <p>Informant BD, September 2012</p>	
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Table 7

Topic	Site A	Site B (Kotamadya)	Site C (Kabupaten)
Clean water and drinking water sources	<p>"Majority are using <i>PAM</i> water (from the water utility company PDAM). There's normally one connection per house [...] (The taste of the <i>PAM</i> water) There's nothing wrong for those who are already used to it... [...] There's rarely a water cut here, unless there's been an announcement about land slides. Also during the <i>Idul Fitri</i>, when people are most hectic, prior to the Id prayer... It tends to shut out, and we would often store some water in a washbasin."</p> <p>Informant AA, September 2012</p> <p>"Well... Most of the time our mother takes buckets (of water) from the washroom by the river. (The <i>PAM</i> water) is hardly used. For drinking water, our father still prefers the water down by washroom.</p> <p>[...] (The <i>PAM</i> water) is used for washing dishes, for (after) excreting, to wash our face and brush our teeth, that's all [...] There's a weird taste and smell with the</p>	<p>The locals are connected to the service line of the water utility company (PDAM Kota Bogor)</p> <p>"<i>Alhamdulillah</i>, I have no issues using the well water. [...] The well is 9 m deep. [...] The water (quality) is also good for drinking water, as you have tried right? "</p> <p>Informant Pak RT, September 2012</p> <p>"I have <i>PAM</i> water at home (connected to the water service line of PDAM Kota Bogor). <i>Alhamdulillah</i>, we have been using it for over a year now. We had a down payment and then for the remaining amount we paid a monthly installment of IDR 125 000 per month for 6 months. [...] Before I was using water from the well. [...] It was 15 m deep. [...] You see, during the dry season the wells would dry out and if you want to drink the water it smells. [...] The <i>PAM</i> water in BB's home was</p>	<ul style="list-style-type: none"> Clean water are taken from the well. Buy refillable drinking water gallons. Wash clothes by the river. Since the construction of the MCK, it also becomes one of the sources of water. <p>Informant CB, September 2012.</p>

	<p>PAM water... Like a chemical. We tried few times, perhaps it was due to the new connection, but the second and third time it remained that way, so we only use it to wash the kids. When we cook water, we would take from the place below [...]</p> <p>Informant AD, September 2012</p> <p>"We take PAM water [...] People (here) rarely buy (additional) drinking water. "</p> <p>Informant AT, September 2012</p> <p>"PAM water. [...] But the majority here consume the PAM water, only a few percentage (of the community) takes water from below... Very little... [...] Within the house, (the families) have joint (PAM water) connections [...] There are few that buy their drinking water. I also... [...] Sometimes, you see... I can't be bothered having to boil the water. So, using the (refillable) water gallons is easier... [...] Yes, and I am also selling cold drinks, then (I) must cook the water and then cook more water again. So, mostly buying the (refillable) water galloon. But I do know that most people around here use the PAM water."</p> <p>Informant AR, September 2012</p> <p>"PAM water... [...] We seldom buy (additional water for drinking). [...] We go down to the big stream to wash, when it overflows or floods, we go home."</p> <p>Informant AI, September 2012</p>	<p>also paid in installments. [...] I also use the <i>PAM</i> water (for drinking water). [...] Yes, sometimes we buy the refillable water gallons if we have the money. [...] It's all about the money. [...] Well, one (refillable water) gallon is IDR 5000. [...] If we don't have the money, then we could just easily cook the <i>PAM</i> water. You can just press the button of the water heater to boil it. Well ma'am, it is not compulsory to buy the (refillable) water gallons. "</p> <p>Informant BA, September 2012</p> <p>"During the dry season, the water from my well smells so bad. That's why we took the credits/installments from the bank. I had just made the first payment. At the beginning it was IDR 500 (000), and then the installments goes for 7 months for IDR 100 (000) per month. [...] Sometimes we consume the refillable water gallons as the for our drinking water. [...] Normally we would cook the water, but then if the gas runs out, then we would buy (the drinking water). [...] No, it (a refillable water gallon) costs IDR 3000, (BA) should not include the delivery cost. [...] There's the IDR 9000 water gallons, and these are the clean and healthy water. So, for the refillables, if we have the money, we would order the IDR 9000. [...] Yes, I also tend to like (the taste of) the IDR 9000 water. [...] Generally the water is also used as hot water for coffee. [...] The water from the well at my house is completely murky. [...] Yes, drinking water from the well is better. [...] You can smell the chlorine from the <i>PAM</i> water."</p> <p>Informant BB, September 2012</p> <p>"Well... the <i>PAM</i> installed in my home has been there for a very long time. Years and years... since the beginning. I think it is already more than 10 years. It's been quite a while. [...] When there's no gas to boil the water, then we would purchase water gallons. [...] But to be honest, water has is not really something that's you know (an issue)... nothing really worrying. [...] Most of the time I boil the water. [...] Also, the <i>PAM</i> water gets this smell, like what is it, chlorine? [...] The well water at my place is not clean. "</p> <p>Informant BC, September 2012</p> <p>"I am using the <i>PAM</i> water (connected to the water service line of PDAM). My current home was originally my mothers' place and she has had it for over 5 years</p>	
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		<p>now. [...] When there's the money (to buy refillable water gallons for drinking water). [...] If there is no more gas (at home) then I would buy drinking water. [...] It (the taste) is different. You see, normally my mother would only drink the IDR 9000 water at home. [...] Well, I cook my <i>PAM</i> water by myself at my place, and my mother said that it was not tasty. She said that the water was musty. [...] You (Pak RT) have good well water because you're house is nearby the stream. The water is mostly clear, unlike ours... [...] It seems like the well water is much better for consumption right? I mean, with the <i>PAM</i> water you can still have this after taste. [...] Especially when I open the tap at full blast, the chlorine taste is evident. That's why I only turn the tap a little to keep a low flow."</p> <p>Informant BD, September 2012</p> <p>I have the PAM water (connected to the water service line of PDAM). [...] Before I had the Sanyo water (well-water abstracted using a jet pump). [...] I do my laundry at the MCK facility.[...] Well, there's no one here that can do the washing. My wife had passed away and the kids are off to school first thing in the morning. [...] So one of my children is paying for the washing service. But I do the dishes at home. [...] I didn't have a well, the wells here have bad quality. [...] I changed to the PAM water, not because the Sanyo water had poor quality. No, the water was fine. It's just that there was a collective (subsidy) for the PAM water (connection fee to the water service line could be paid in installments), so then I also joined in."</p> <p>Informant BE, September 2012</p>	
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Table 8

Topic	Site A	Site B (Kotamadya)	Site C (Kabupaten)
The operation and maintenance of the sanitation facility	<ul style="list-style-type: none"> There was supposed to be a knowledge transfer from the village leader to a caretaker from the area. However he was reassigned to another city before the construction was finalized. (Local authority of Site A). <p>"The MCK facility should be utilized (soon), rather than turning it into a haunted house. [...] When it is that (to collect the money) it is done, but when it's to do (cleaning of the MCK facility), no one wants to do it. [...] So it (the MCK) aimed to facilitate more or less 200 households... but it no longer functions now. [...] In terms of hygiene (when comparing the two facilities), there (the shed by the river) is clean, whereas here (the MCK facility) is dirty."</p> <p>Informant AA, September 2012</p> <p>"I guess, there is no other (person) apart from AA ... So, no one takes care of it (the MCK facility). [...] If there was a caretaker maybe it would be cleaner right ma'am? Neat... [...] When we are there (at the MCK facility) there's hardly any water because there's no caretaker. If there was someone responsible for it then maybe..."</p> <p>Informant AD, September 2012</p> <p>"There's no one maintaining the facility... No one."</p> <p>Informant AR, September 2012</p> <p>"You see, with us... when we see the basin is empty, then that's it, we leave (the MCK facility)."</p> <p>Informant AI, September 2012</p>	<p>The facility is clean and well maintained Score: 4,4,5,5 (Agree) FGD, September 2012</p> <p><i>The facility is cleaned and well maintained by the head village and the head of the sub-village. (Pak RW and Pak RT)</i></p> <p>"Occasionally, we have people throwing sanitary napkins into the toilet, and condoms too... making it clogged."</p> <p>Informant Pak RT, September 2012</p> <p>"I don't get problems with the bad smell..."</p> <p>Informant BA, September 2012</p> <p>"No, not really. Well... it won't be a problem. At times... after we finished our washing... after this, we would clean and mop the area (of the MCK facility). But of course, there are those that would do it (clean up after using the MCK facility), and those that wouldn't... Sometimes, after they do their washing, then they'd just leave. But I don't do that. After I do my washing, I clean up afterwards and rinse the place so (the floor) it doesn't get slippery. [...] There are condoms too at times, clogging the closet. I watch the cleaning up. [...] I would report to Pak RT when it may be clogged, you know odors start to seep inside (my home). [...] When it clogs the bad smell gets inside (the house). Well, these two always get it (BC and BD). [...] Of course you (BA) don't get affected, you live further up."</p> <p>Informant BB, September 2012</p> <p>"Sometimes when it is like that (to clean up)... then, it's okay. [...] Yes, there's the terrible smell."</p> <p>Informant BC, September 2012</p> <p>"You get this strong smell when it's overflowing. [...] Especially during the rainy season."</p> <p>Informant BD, September 2012</p>	<p>- It is very clean</p>

Table 9

Topic	Site A	Site B (Kotamadya)	Site C (Kabupaten)
User's conflict for the sanitation facility	<i>Not present</i>	<p>"But if it were for the users from outside of B then who cares right? They're the ones that's tagging along. We own the place. We are the ones maintaining and taking care of it (the MCK facility). [...] It's okay if they want to use it as well as long as they pay the (monthly) fee. [...] We (the people from B and the people from C) are very different. [...] We are from different districts. [...] Imagine if it was us that tagged along to C, oh no, that would not be allowed. [...] Indeed, they would talk (complain) a lot. [...] Here, nobody's commenting (on the C people tagging along to the MCK facility). [...] Now, at the MCK facility, they (the residence of C) use it like they own the place. [...] Then you see them taking water gallons (from the MCK facility) to their homes. "</p> <p>Informant BA, September 2012</p> <p>"No... We are not bothered. [...] The MCK facility becomes crowded sometimes at night. No, it's not a big deal. [...] It's usually the people from C that goes there (to use the MCK facility), especially during the dry season. [...] Well, they normally go to the side of the stream (to do their washing). [...] Like now, they'd be down by the stream because it's the rainy season, but later when it is the dry season they'd come running back to the MCK (facility). It would be used again by the people from C. [...] Right now, there are only several steady users from C (that are still using the MCK facility during the rainy season). [...] But for outsiders, well, then it's okay (to pay the current fee of IDR 15000), as they are tagging along with us (to use the MCK facility). [...] I mean, the people from B and from C are just different. We have different <i>RT</i>, I mean <i>RW</i> right? [...] Oh, we would not be allowed to join them (at C). [...] When I did my washing at the stream, well, they just kept talking about it. [...] But if you see now, they're using our MCK facility, and you don't hear us talking about it. [...] When we were washing there (by the river), they were (purposely) taking their time and we had to wait for them. Afterwards they also hovered around as we did our washing. [...] Sometimes you see (the MCK facility) is filled with their kids (from area C) bathing and all. [...] So you see, it is the people from C</p>	<p>"You see, Mrs. CC... is a lot. I mean, sometimes I feel, well, last time there had been some misunderstandings. Well, it's because Mrs. CC talks a lot. I mean, she's the one that uses a lot of water, and she's the one that blabs the most to others. I said to myself, "Ugh, how come she talks (and complains) so much? When in fact she's the one that uses (the MCK facility) the most." Even her entire family wash themselves there. And then when they head home, they take some water (with them). They wash there multiple times (a day). But not me."</p> <p>Informant CA (September 2012)</p>

		<p>that uses it (the MCK facility) the most. But it's not really a problem for the locals here at B. [...] I also only do my washing once a week, that's why I'd be seen dominating the MCK (facility) every Sunday. [...] Welll, but not anymore because I have installed the <i>PAM</i> water (connect to the water service line of PDAM) at home. "</p> <p>Informant BB, September 2012</p> <p>"A lot of the users come from C. [...] That is not a problem. [...] But they (people residing in C) would go to the stream (and do their washing) when it is the rainy season. [...] Sometimes people become envious of the large water consumption (of people from C).</p> <p>Informant BC, September 2012</p> <p>"They (the locals of C) used to come around and ask for donations to make their own washing area (by the river). [...] (In comparison to people from C) we only use the water to do our washing. "</p> <p>Informant BD, September 2012</p>	
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Table 10

Topic	Site A	Site B (<i>Kotamadya</i>)	Site C (<i>Kabupaten</i>)
Retribution fee of using the facility	<p>"One of the reasons why people are reluctant to use the MCK facility is because of the fee. Why should they pay when they can go for free by the river?"</p> <p>Informant AA, September 2012</p> <p>"I would rather pay the (IDR) 1000 rather than being embarrassed."</p> <p>Informant AT, September 2012</p>	<p>Resident: E 0.40 / month / hh Non-resident: E 1.20 / month / hh</p> <p>"Fortunately, the electricity bills are now being covered (paid) by one of the members of the community. But for the <i>PAM</i> water (water from the PDAM service line), now that has to be paid (collectively by the users). [...] But I don't know the procedures of the payment of the water bills. I am only in charge of the electricity bills."</p> <p>Informant Pak RT, September 2012</p> <p>"Of course you'd still need to pay, but not (that) much.</p>	<p>"At the very beginning (the fee) was IDR 6000. And I said "How come (only) IDR 6000? Would that be enough to pay the (water) bills?" [...] (So I said), "<i>Pak RW</i>, perhaps you should change the system, and each one that goes there pays IDR 1000 each time. So the ones that go there 2 – 3 times has to pay more than once." Perhaps that way it could cover the bill? Then, it increased again to IDR 10000. I was still thinking... I mean, to myself, "Could they pay (the bills)?" [...] to the MCK facility (IDR) 15 (thousand) [...] Yes, (IDR) 15 (thousand), but even so, I'm still thinking to myself [...] You see, when we first started the fee was (IDR) 6000, and it couldn't cover the bills. But now, well, I don't</p>

		<p>[...] Who (said I) chose number 5 (to completely agree that there should be no fee charged for using the MCK facility)? We still value you (your work) Pak RT. [...] Yes, if so, later Pak RT will be sulking at me. [...] Yes, but it (the MCK fee) is too high. Sometimes people are only doing their washing there. They don't bathe and do everything else there (at the MCK facility). [...] Well, what I'm trying to say is that perhaps now it could be considered to lower the fee down to IDR 5000 (per household) per month. I mean, we're only doing our washing there (at the MCK facility). [...] Well, it (paying directly after each usage) could work, but only if we have money each time we go there (to the MCK facility). What happens if we're broke? Then we don't go... [...] I would suggest that we do it collectively and take one of the community members to be in charge. Let's say each month IDR 5000 (per household), that's (more) affordable right? But if it were for the users from outside of B then who cares right? They're the ones that's tagging along. We own the place. We are the ones maintaining and taking care of it (the MCK facility). [...] It's okay if they want to use it as well as long as they pay the (monthly) fee. [...]. It (the MCK facility usage fee) is too much. Not to mention the water fee (at my home) is IDR 30000 per month, inclusive... Including all the (water usage for) washing."</p> <p>Informant BA, September 2012</p> <p>"Yes (we must pay to use the MCK facility). [...] There's also the electricity bill that needs to be paid. [...] At the beginning, the fee to use the MCK (facility) is IDR 6000. [...] Yes, initially it (the MCK fee) was IDR 3000 because we were using the water from the well, and then it increased to IDR 6000. It turned out that the water bills were quite pricy, so... it rose to IDR 10000. Even that was still not enough, and now we're paying IDR 15000 (per household per month). We all agreed to pay IDR 15000. [...] Well, however the usage is (at the MCK facility), everyone pays an equal amount (each month). Whether you use as much or as little water, so long as you use it (the MCK facility), everyone is paying the same price. It's divided evenly (among the users). [...] That system (paying directly after each usage) could work, if people understood it completely. What happens when they don't? It will be complicated. [...] So how? We put a box there (at the MCK facility) and each time</p>	<p>know. I can only hope that the bills can be paid."</p> <p>Informant CA (September 2012)</p>
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		<p>someone wants to bathe, they have to put (money) into the box?... That is impossible. As if people were going to pay directly (after usage). [...] Well, you do know that most of the users are people from C. They hardly use the PAM water (connected to the PDAM water service line). [...] Yes, IDR 5000 per month (per household) is reasonable. But for outsiders, well, then it's okay (to pay the current fee of IDR 15000), as they are tagging along with us (to use the MCK facility)."</p> <p>Informant BB, September 2012</p> <p>"We must pay. It isn't appropriate if we use it (the MCK facility) as we please and not pay anything for it. [...] Well, at the very beginning the fee (for using the MCK facility) was IDR 3000. [...] That's why it is important that these payments (of the MCK fee) should be monitored carefully. People said that before the fee (to use the MCK facility) was not being paid. Then you get the really high water bills and we ended up not being able to cover the costs."</p> <p>Informant BC, September 2012</p> <p>"Yes (we must pay to use the MCK facility)... Well, there's the water fee (water from the PDAM service line) that needs to be paid"</p> <p>Informant BD, September 2012</p>	
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Table 11

Topic	Site A	Site B (Kotamadya)	Site C (Kabupaten)
Past need of a sanitation facility	<p>"People were informed about the construction [...] Local leaders talked about it, signatures were asked. [...] There were community discourse (regarding the MCK facility). It was also the local community that asked for it, and then also from the District Authority <i>Cipta Karya</i>. We had discussed it with RT II (sub-village II)."</p> <p>Informant AA, September 2012</p> <p>"Yes, we knew (about the plan to construct the MCK facility)."</p>	<p>Initially, a mosque was agreed upon to be built in the area.</p> <p>Scores: 2, 2, 2, 5</p> <p>FGD, September 2012</p> <p>"Well... I didn't know about it (the plan to construct an MCK facility). But I'm not sure, whether to disagree or not. I mean, I do agree in a sense that... well, it's good so that it helps with our PAM water fees. Like, you know,</p>	<p>"First of all, I myself am very-very thankful (for the presence of the MCK facility) as it has been a tremendous help."</p> <p>Informant CA (September 2012)</p>

	<p>Informant AT, September 2012</p> <p>"Yes, we knew (about the plan to construct the MCK facility)."</p> <p>Informant AD, September 2012</p> <p>"Yes, we knew (about the plan to construct the MCK facility)."</p> <p>Informant AR, September 2012</p> <p>"Yes, we knew (about the plan to construct the MCK facility)."</p> <p>Informant AI, September 2012</p> <p>"Yes, we knew (about the plan to construct the MCK facility)."</p> <p>Informant AM, September 2012</p> <p>"Yes, we knew (about the plan to construct the MCK facility)."</p> <p>Informant AN, September 2012</p>	<p>we can go to the MCK and minimize our usage (at home). [...] The (existing) Musholla is far... We all agreed to build a Musholla. [...] Well, at least we were hoping to suggest for an affordable monthly fee... But we just agreed, and it was done (constructed)."</p> <p>Informant BA, September 2012</p> <p>"Before, what was it... instead of building the MCK facility, there was going to be a playgroup. But then, turns out, everyone (pretty much) needed an MCK facility, so it was decided then for the MCK facility. [...] So initially it was like this... we installed the PAM (connected with the PDAM service line)." (continued at the back)</p> <p>"Well for me... back then I really lacked water. You know the PAM water, No, I meant the well water. So I also need for drinking water consumption... The well water's dirty. So, I did need the MCK (facility). [...] Yes, we needed a Musholla, because that's something that we don't have. None at all (in our area)... This is the nearest Musholla. [...] At least there (the MCK facility) was a shield guarding the edge. You can see that there's a huge gap, and we feared that our kids would fall if they were playing there."</p> <p>Informant BB, September 2012</p> <p>Before, you see, in front it was going to be built next to it... a play group.</p> <p>"Well, we support it (the construction of the MCK facility) so that it's guarded (at the edge prior to the river) and the kids are safe. But you see... (I) have our own PAM water. So then it's kind of paying double the fee. Well, we're only following as a form of support for the rest (of the community). [...] What we had agreed upon was actually the construction of a Musholla... A lot (of the community members) agreed for a Musholla. [...] Many (of the community members) did wonder, 'How come it was not the Musholla (that was not constructed)?'"</p> <p>Informant BC, September 2012</p> <p>"Musholla, indeed... It's quite a distance to come here when we want to pray. [...] Back then we did our washing together, so more space was needed. I used to</p>	
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		<p>live at my parents' and we all did our washing at home. So, having the MCK (facility) was really good, because then it was more spacious to do our washing. Back at home, the bathroom is small, so we scrambled to get a spot. But that wouldn't be the case anymore if there's a public (MCK) facility. Those who wanted to shower (at home) could do so, and those wanting to do their washing could go to the MCK (facility). But after I moved (to my current place), I never have to go to the MCK because I have my own private bathroom."</p> <p>Informant BD, September 2012</p> <p>"The need of an MCK (facility) was definitely an urgency. If we didn't have the MCK (facility), it would be dangerous. There was a huge gap there... before. [...] So, now, it is much safer, we have the MCK (facility) there. In general, the local community needed it (the MCK facility), back then... But now... Well, in the past there weren't many with the PAM water (being connected to the water service line), that has only changed just recently.</p> <p>(Yes) I have a toilet at home. [...] Well, I do use go to the MCK (toilet) once in a while, and the kids too. When it gets pretty crowded here on a busy morning, we'd go there (to the MCK facility)."</p> <p>Informant BD, September 2012</p> <p>The project was initiated by the village leaders as a part of the image building after winning the award from the city council. Of course, there were a lot of funds involved in the project.</p> <p>Informant BF, September 2012.</p>	
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Table 12

Topic	Site A	Site B (Kotamadya)	Site C (Kabupaten)
Present need of a sanitation facility	<p>"There is a need (for such facilities) from the local community. [...] Currently most of the locals here still live in their parents' house. So maybe, if their in-laws decided to build a washroom/toilet, then they would have it (at home). [...] There is actually space available</p>	<p>The facility is clean and well maintained Score: 4,4,5,5 (Agree) FGD, September 2012</p> <p>"So... you see, because the MCK facility fee is now IDR</p>	<p>"So I am truly really grateful for the presence of the MCK facility. If it doesn't exist, what will happen to me? I don't want to use the water from the stream and I wouldn't even dare to cook using the water from the well. No. Except perhaps to wash dishes, or for bathing</p>

	<p>to create the bathroom.” Informant AA, September 2012</p> <p>“We would like to do it (excrete) in a bathroom [...] We do need it, but we don’t use it (the current facility). [...] Yes, we have thought about (building private toilets at home). [...] I guess we could build it (a toilet at home), but maybe it’s the cost (that becomes an obstacle).” Informant AD, September 2012</p> <p>“Of course, the number one concern is the cost, if we have the money then we would definitely do so (to construct toilets at home). Informant AT, September 2012</p> <p>“I have my own toilet at home.” Informant AR, September 2012</p> <p>“If we have our own house, then we would consider it (to create private toilets). [...] Besides, it would not be very convenient to construct a washroom/toilet at the house of our in-laws. Informant AI, September 2012</p>	<p>10000 – 15000, then I don’t end up going there, and instead I use the our water source at home, because well... I’m paying the same (fee) at home and for using the MCK (facility). [...] Well, there are only a few people using the MCK facility nowadays, because most of us have our own PAM water.” Informant BA, September 2012</p> <p>“The present users (of the MCK facility from B) aren’t that many anymore, the number decreased because people have installed the PAM water (connected to the water service line of the PDAM). You can say, almost everyone in our community. [...] Well, sometimes, you see it depends, perhaps if we don’t have enough water (at home) we’d go running back there (the MCK facility) again. [...] Like I said before, I only have one bathroom (at home) and in the morning sometimes my kids either have a stomach ache, or whatever, so then... go to the MCK (facility). [...] I still do need (the MCK facility) because of that. [...] Nowadays, most of the users use the MCK facility only to do their washing. [...] You would need the MCK facility, if, for example you’re holding a special gathering (celebration) at home, and sometimes there’s just not enough (water) to wash all the dishes. [...] Then you would need to use it (the MCK facility).” Informant BB, September 2012</p> <p>“Well, if we don’t have the money to pay for the MCK facility, then we don’t dare to use it.” Informant BC, September 2012</p>	<p>[...]Well, truly for me Miss, I am so grateful. If there’s no MCK, My goodness... I don’t know [...]Oh, Ihh... It has helped me truly very-very much, I am so thankful. If it doesn’t exist, then that’s it. I like to share with my kids miss, “We’re so lucky right, if there’s no MCK (facility), the stream looks like that, how will we wash?” I would say. And also, our well water has gone murky. What? Do we then have to go to our siblings’ or our parents’ place? That’s far.” Informant CA (September 2012)</p> <p>Score: 5 Informant CB (September 2012)</p>
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Table 13

Topic	Site A	Site B (<i>Kotamadya</i>)	Site C (<i>Kabupaten</i>)
Future usage of the sanitation facility	<p>“Well if you see (around) there are plenty of new paths being opened. It is guaranteed that later on the MCK facility will be crowded. ” Informant AI, September 2012</p>	<p>Scores: 3,3,3,3 FGD, September 2012</p> <p>“That’s why you see, if there’s not much pressure to pay the monthly fee, then people would be more (free) willing to use it. [...] If the monthly fee is lowered, then yes (I would use it), because it will help cut down costs.” Informant BA, September 2012</p> <p>“If the water bill goes down. Also sometimes when</p>	<p>“I am going to continue using the facility. We’re very lucky.” Informant CB (September 2012)</p>

		<p>there's no water running from the tap (water cut from the service line of PDAM), and the MCK facility has a storage then I would use the MCK facility to do my washing again."</p> <p>Informant BB, September 2012</p> <p>"Perhaps (the MCK facility will be used) when there's a water cut from the service line (of the PDAM)."</p> <p>Informant BC, September 2012</p> <p>"Yes (the MCK facility will be used), if the (monthly) goes down."</p> <p>Informant BD, September 2012</p>	
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Table 14

Topic	Site A	Site B (<i>Kotamadya</i>)	Site C (<i>Kabupaten</i>)
Environmental concern (awareness)	<p>"Anyway, now if you want to discharge (the effluent from washroom/toilet) into the river it is no longer possible, because there is the concrete layer on the side wall. Do we have to knock it down? Of course people don't want to connect (to a sewerage line). What happens if it is not maintained properly, if there's rubbish or if it gets clogged? [...] One of the challenges in this area is that the local communities have not yet developed the awareness of healthy and hygienic lifestyle."</p> <p>Informant AA, September 2012</p>	<ul style="list-style-type: none"> • It is difficult to get the children not to buy food from outside. Even if we provide them with packed lunch, they will finish that and still buy from outside. • It's expensive to cook at home and having to buy all the ingredients. 	

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