Understanding how people innovate for emergency sanitation: A case study of a local NGO

Y. P. Thyea,*, A. J. Effendi, P. Soewondo, D. Brdjanovic and T. Setiadi

a Department of Environmental Engineering, Bandung Institute of Technology, Jl. Ganesa 10, Bandung 40132, Indonesia
b UNESCO-IHE Institute for Water Education, P.O. Box 3015, 2601 DA Delft, The Netherlands
c Centre for Environmental Studies (PSLH), Bandung Institute of Technology, Jl. Sangkuriang 42A, Bandung 40135, Indonesia

*Corresponding author. E-mail: yokepean@gmail.com

Abstract

Emergency sanitation technologies make up some of the most significant gaps in the water, sanitation and hygiene sector. Major initiatives to address identified gaps may be characterised as donor-funded, top-down processes driven by international or European-based non-governmental organisations. However, local organisations also innovate. To better understand how local organisations innovate for emergency sanitation, the paper presents a case study of an Indonesian NGO who had developed a toilet for use in emergencies. The NGO developed the toilet by modifying an existing non-emergency toilet. The process was unstructured and informal. When testing ideas, for instance, the NGO used their own methods rather than referring to testing protocols recognised by the industry. The NGO surveyed end users, but the respondents did not come from post-disaster settings. Compared to designs developed through international initiatives, the NGO’s design deviated somewhat from internationally recognised standards, for instance, the size of the latrine slab. The paper also discusses differences between the way local and international organisations develop emergency sanitation products. Each approach has advantages and disadvantages in terms of methodology and access to resources and expertise. Therefore, there are potential benefits to the different organisations working more closely.

Key words: emergency, innovation, sanitation

INTRODUCTION

Emergency sanitation technologies make up some of the most significant gaps in the water, sanitation and hygiene (WASH) sector, according to an extensive stakeholder consultation comprising beneficiaries, practitioners and donors. The gaps include: latrines in locations where no pits are possible; latrine emptying and desludging; urban alternatives for excreta disposal; final sewage disposal options, and; non-toilet options (Bastable & Russell 2013).

Major initiatives to address identified gaps are S(p)eedkits (www.speedkits.eu), the Emergency Sanitation Project (www.emergencysanitationproject.org) and the Humanitarian Innovation Fund (www.humanitarianinnovation.org). These initiatives may be characterised as donor-funded, top-down processes driven by international or European-based non-governmental organisations (NGOs). For instance, the S(p)eedkits project comprises humanitarian agencies, NGOs, academia and private sector partners from Italy, Belgium, the Netherlands, Luxembourg, Norway and Germany.

On the other hand, there are local companies or NGOs who innovate for emergency sanitation outside of the aforementioned initiatives. They also play an important role in overall innovation within the sector, although their activities are not as well documented.
To better understand how local organisations innovate for emergency sanitation, the authors carried out a case study of an Indonesian NGO who had developed a toilet for use in emergencies.

**METHODOLOGY**

A team of two researchers from the Bandung Institute of Technology visited the NGO’s head office in April 2014 where the product was developed. A semi-structured interview was conducted with the Research and Development (R&D) manager who led the development of the emergency toilet. Following the interview, the R&D manager guided the researchers through a brief visit of the premises so that the researchers could observe and better understand some of the activities the NGO had undertaken.

**ABOUT THE NGO**

Operating since the 1970s, the NGO focuses on appropriate technology in a wide range of sectors, including water and sanitation, water and waste treatment, renewable energy and agriculture and aquaculture. The NGO’s R&D activities are carried out through the R&D department. Comprising four persons, the department conducts R&D into various areas such as sanitation and gasification, and includes hardware and software aspects.

Correspondingly, the emergency toilet was developed by the R&D department.

**THE DESIGN PROCESS**

**Motivations for developing an emergency toilet**

As a development NGO, the organisation does not have specific interests towards emergency response in general. However, they may choose to respond to disasters on a case-by-case basis, and have done so before.

As a result, the organisation had first decided to design a toilet for non-emergency, rather than emergency, situations in Indonesia. (However, it should be noted that the final product was subsequently also implemented in a post-emergency situation.) The need for ‘hardware’ was identified because the NGO felt that existing sanitation programs, which emphasized ‘software’ components, were not sustainable due to the lack of ‘hardware’ to provide physical access to sanitation. This led to the development of the first product.

Approximately one year into the development of the first product, the NGO felt that concept was good but a better solution could be created. The first product had been implemented in a post-emergency situation, one month after a disaster. Most had been implemented at a household-level, but public toilets were also installed.

Therefore, the organisation started developing a ‘toilet-in-the-box’: a toilet for implementation in emergencies that would also be suitable in non-emergency situations. At the time of the interview, the product had been developed but had yet to be implemented in an emergency situation. The organisation was in the process of promoting the product to relevant humanitarian agencies.

At that point in time, the NGO also had an idea to develop a similar product that would be suitable for situations with limited water. However, they were uncertain whether this would go ahead.

**Overall design approach**

The approach used by the NGO for the emergency toilet was simple: to modify the design of the first product so that the toilet could be packed into one box. On the other hand, the first product had been
developed from scratch. Therefore, compared to the first product, the emergency toilet took a significantly shorter time and significantly less money (Table 1).

### Table 1 | Comparison of overall design process between the first product and emergency toilet

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>First product</th>
<th>Emergency toilet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach</td>
<td>Designed from scratch</td>
<td>Modified from first product</td>
</tr>
<tr>
<td>Time taken</td>
<td>14 months</td>
<td>5 months</td>
</tr>
<tr>
<td>Funds spent (approximately)</td>
<td>US$ 10,000</td>
<td>US$ 2,500</td>
</tr>
<tr>
<td>Number of people involved</td>
<td>Four persons (i.e. the R&amp;D team)</td>
<td></td>
</tr>
<tr>
<td>Decision-making</td>
<td>Final decisions made by R&amp;D manager (interviewee)</td>
<td></td>
</tr>
</tbody>
</table>

Furthermore, through the first design process, the NGO had acquired expertise on various technologies and materials. Most of the funds for developing the first product went to sampling equipment and materials. Therefore, the emergency toilet was much cheaper to develop.

### Design requirements

The initial design requirements were based on the NGO’s experience with their sanitation program in a specific area of Indonesia. The team tapped on feedback from their colleagues in the field. For example, the R&D department determined that the toilet must have legs because the program was being implemented in a tidal area. Additionally, they decided that the toilet should be ‘as cheap, robust and as beautiful as possible’.

Some requirements were presumed, given that the NGO was working within a local culture that they were a part of. For instance, it was assumed that water would be used for anal cleansing. The team determined that 1.1 to 1.2 litres of water would be used for flushing and anal cleansing. Assuming that each person would go to the toilet twice per day, the design was developed based on 15 litres of water and excreta being produced per person per day.

One month after starting the product development process, the NGO decided to conduct a survey to better understand the design requirements. Examples of the needs that the organisation was interested in included space requirements, material, colour and the purpose of using toilets. The department surveyed approximately 500 people by reaching out to colleagues at the office, residents in nearby villages and other people they knew.

For example, 98% of the respondents felt uncomfortable using a toilet with a tarpaulin wall. Therefore, alternatives were explored. In addition, most of the respondents felt comfortable in a 1 m by 1 m space. Therefore, the team decided that the toilet should have internal dimensions of at least 1.1 m by 1.1 m. The final, exact, dimensions depended on the manufacturer’s constraints.

### Choosing materials

During the design process, the team focused on choosing appropriate materials for various components of the toilet, such as the wall, floor and slab (Table 2). No one in the organisation had specific expertise on materials. Hence, ideas were generated based on personal knowledge, by searching the internet, visiting exhibitions and through personal contacts. For instance, the team searched the internet to find ideas for how to make a frame for the toilet. The department also attempted to contact various suppliers but some companies did not respond, partly because the team’s requirements were too low.
Alternatives were evaluated by building prototypes and exposing them to the environmental conditions at the NGO’s premises, which included sunlight, rain and tannery fumes. Leaving it outside for two to three months helped the team assess the materials’ durability. The R&D department also asked groups of people to experience the different prototypes. The advice and comments from them helped the team choose the materials.

For example, the NGO had initially felt that aluminium would be too expensive. Hence, the organisation first considered using steel or concrete. However, steel had to be cut and welded and concrete was too heavy. Eventually, the R&D department discovered that aluminium was not as expensive as they expected. Aluminium was also easier to fabricate.

For the wall, the team considered geomembrane-type material and material commonly used for toilet doors. However, geomembrane was too hot, flimsy, and difficult to mount onto a frame. The material common in toilet doors was too thin and difficult to manufacture. Although the manufacturer stated that the material would last four to five months with ultraviolet coating, the coating was too expensive. Therefore, the final design used a polyvinyl chloride (PVC) celuka board. The team also discovered later that the PVC celuka board was able to absorb some sound, which was considered an added benefit because sound had not been explicitly considered during the design process.

Fibreglass had been considered as a material for the floor. However, geomembrane was too hot, flimsy, and difficult to mount onto a frame. The material common in toilet doors was too thin and difficult to manufacture. Although the manufacturer stated that the material would last four to five months with ultraviolet coating, the coating was too expensive. Therefore, the final design used a polyvinyl chloride (PVC) celuka board. The team also discovered later that the PVC celuka board was able to absorb some sound, which was considered an added benefit because sound had not been explicitly considered during the design process.

Fibreglass had been considered as a material for the floor. However, it was too thin and led to cracks. The team also tried to modify plastic palettes but it required too much effort. Later, a ‘special material’ was identified. The material was cut and placed on the roof. Then, the team’s colleagues were asked to try out the floor. The floor was found to flex under the weight, hence a beam was added. The ‘special material’ was chosen because it did not become slippery when wet, minimising accidents and increasing safety.

**Design of the septic tank**

Septic tanks are the most common form of sanitation in Indonesia. 72% of urban households and 48% of rural households had septic tanks in 2012 (Statistics Indonesia 2013). Therefore, the NGO also used a septic tank in its design.

For the first product, a standard fibreglass septic tank was used. The NGO analysed a few samples to confirm the treatment efficiency of the system.

For the emergency toilet, the septic tank had to be foldable because the standard tank would take up too much space for transportation. A collapsible PVC membrane was chosen. As the team’s main concern was cracking, they tested the septic tank by filling it with water for five days, draining the water, folding up the tank and refilling the tank again. The material was deemed suitable after the septic tank remained intact after three months.

**Other design considerations**

Table 3 describes a number of other factors that was considered during the design process.
One interesting point to note is that the emergency toilet is sold at approximately US $780. Although the interviewee considered the toilet cheap compared to other products available in the market, Oxfam GB (2013), in its Calls for Proposals for raised latrines, had a target cost of £150 (US $240), approximately one-third of the price of the NGO’s product. However, the NGO includes transportation and installation in its selling price, which makes the comparison challenging.

Challenges faced during the design process

The main challenge faced by the NGO was that it was difficult to obtain different types of material, partly because the organisation was based in a city where materials were more difficult to access, and partly because it was difficult to get support from suppliers as the team only wanted small amounts of the material. The NGO was able to overcome this, to an extent, through leveraging personal connections. For example, the material for the floor was identified by a colleague from China.

The interviewee suggested that there should be a platform to allow people to move forward together, because nobody could understand every aspect of the product development process. However, the interviewee stated that university collaboration in the Indonesia was not easy, yet.

**DISCUSSION**

**Critiques of the design process**

The R&D team used a simple design approach by modifying an existing product that was developed for non-emergency situations. The majority of the design was the same except that all the parts could

---

**Table 3 | Other design considerations and features**

<table>
<thead>
<tr>
<th>Design criteria</th>
<th>Design decision or feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>First product: Rp 6.5 million (Approx. US$ 530)</td>
</tr>
<tr>
<td></td>
<td>Emergency toilet: Rp 9.5 million (Approx. US$ 780)</td>
</tr>
<tr>
<td>Number of people per latrine</td>
<td>Based on ten persons per household, but capable of serving more persons per latrine</td>
</tr>
<tr>
<td>Life-span</td>
<td>15 years, based on the manufacturer’s specification for the wall</td>
</tr>
<tr>
<td>Colour</td>
<td>Bluish-white. From the survey, the NGO had determined that the colour should not be dark.</td>
</tr>
<tr>
<td></td>
<td>White was easier to maintain and bleach, and made the toilet feel bigger. However, the</td>
</tr>
<tr>
<td></td>
<td>manufacturer was only able to provide a bluish-white material.</td>
</tr>
<tr>
<td>Anal cleansing</td>
<td>Users are expected to provide their own bucket, although the organisation would assist with</td>
</tr>
<tr>
<td></td>
<td>installing water pipes</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>Provision of a smooth surface</td>
</tr>
<tr>
<td>Flies and odour</td>
<td>No specific design, although the water seal should help to prevent odour. The team reasoned</td>
</tr>
<tr>
<td></td>
<td>that this would depend on the usage and cleanliness of the toilet</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Provided by modifying the design based on local peoples’ needs and requests</td>
</tr>
<tr>
<td>Privacy</td>
<td>Lockable doors</td>
</tr>
<tr>
<td>Lighting</td>
<td>Not provided, but can be installed independently</td>
</tr>
<tr>
<td>Weight</td>
<td>First product: Approximately 75 kg</td>
</tr>
<tr>
<td></td>
<td>Emergency toilet: Approximately 135 kg</td>
</tr>
<tr>
<td>Installation time</td>
<td>First product: One day with three persons from the NGO</td>
</tr>
<tr>
<td></td>
<td>Emergency toilet: Seven hours with three persons from the NGO</td>
</tr>
<tr>
<td>Standard operating procedures</td>
<td>None. Based on the organisation’s experience, people did not read instructions. Therefore,</td>
</tr>
<tr>
<td></td>
<td>the team tried to design a product that was easy to use, operate and maintain.</td>
</tr>
</tbody>
</table>
be packed into a box. While this may be an effective way of innovating in terms of saving time and resources, this approach may restrict the novelty of the final design compared to an approach where the team starts from a blank sheet.

Some design requirements were very specific (for example, the toilet must have legs) while others were more generic (for example, the toilet should be as cheap, robust and as beautiful as possible). Specific requirements are easier to realise and evaluate but may restrict the exploration of ideas (for example, floating toilets could be a suitable alternative to having legs). On the other hand, if the requirements are not appropriately defined, they are impossible to measure and assess.

Although the NGO did conduct a survey with end users, the respondents were not in a post-disaster setting, where attitudes, practices and expectations may be different to a non-disaster setting. Therefore, it may be argued that the results of the survey may not accurately reflect end user needs during an emergency.

Methods of testing (for example, exposure to sunlight, rain and tannery fumes over a period of two to three months) were generally informal and did not conform to industry-level testing protocols. The ASTM (2013) standard D1435–13, for instance, provides standard practices to evaluate the stability of plastic materials when they are exposed outdoors. Therefore, whether the tests done by the NGO actually provided the data that they were looking for is debatable.

Overall, the design process appeared to be unstructured and informal. Nonetheless, the NGO did successfully develop an end product, but it remains to be seen whether there will be significant uptake in the market.

Lessons learned

The NGO only recognised the need for consulting end users one month into the product development process. Based on the survey they conducted they were able to determine specifications for dimensions, colour and so on. The importance of consulting end users should not be understated.

Initially, the organisation had to expend time and resources to gather data on design requirements, materials and so on. Once they had done this, the development of future products were much easier and cheaper. This highlights the importance of knowledge, experience and networks in the product development process.

International versus local

The toilet that the NGO produced was very much a conventional toilet design. However, because the organisation worked independently in a local context for a local market, their efforts resulted in a design that deviated somewhat from internationally accepted standards. For example, a search of the equipment catalogues published by Oxfam, the United Nations Children’s Fund (UNICEF) and the International Federation of the Red Cross and Red Crescent Societies (IFRC) indicate that latrine slabs are typically 1.2 m by 0.8 m or 0.6 m by 0.8 m. The Sphere Project (2011) notes that communal toilets should be provided with lighting, but the NGO did not provide lighting in their final design.

Due to the differences in the product with internationally accepted practices, it is possible that the product would only be able to reach a limited local market. Whether this is a concern of the NGO is unknown. On the other hand, it may also be argued that the final design is more appropriate because it is more aligned to local needs and constraints. As a local NGO, the R&D team had easier access to potential end users than an international NGO. For example, they were able to survey local residents about their preferences, although the respondents were not necessarily disaster-affected.

International projects – S(p)eedkits, Emergency Sanitation Project and Humanitarian Innovation Fund – are largely driven by the customers who buy the end products, (i.e. aid agencies). For example, the Emergency Sanitation Project is led by Oxfam GB, IFRC and WASTE. On the other hand, in Indonesia, there is no demand from the government or other local actors to improve sanitation during
emergencies. Therefore, there is an absence of a concerted effort to innovate. Hasaya et al. (2014), for example, highlights issues with toilet coverage, cleanliness and water supply in the camps in Karo district, North Sumatra. Local organisations who want to address such issues would end up working largely on their own.

This has implications on how various organisations and individuals innovate. Companies and organisations based internationally typically rely heavily on aid agencies during the design process. For example, they consult aid agencies to understand design requirements, evaluate potential concepts, and test prototypes. As a result, the process may be slow and unpredictable because aid agencies often do not have the capacity to respond to product developers regularly.

In contrast, companies and organisations based locally, if they do not have links to international aid agencies, may have to work independently. While this means that they are able to work faster on their own, it also means that they do not have support from potential customers in terms of funding and expertise. It may also be more difficult for them to disseminate the end product.

CONCLUSIONS

The paper provided an insight into how a local NGO developed an emergency toilet. A simple approach, based on the modification of an existing non-emergency toilet, was used. Overall, the process was unstructured and informal. Parts of the process which could have been strengthened included the formulation of design requirements, consultation of end users and application of systematic testing protocols. The importance of involving end users and having access to expertise was also apparent.

The paper also highlighted differences between how local and international organisation develop products. Each approach has its advantages and disadvantages in terms of methodology and access to resources and expertise. There are potential benefits to the different organisations working more closely.

ACKNOWLEDGEMENTS

The authors would like to extend their sincere thanks to the NGO for their support during the study. This research is funded by the Bill & Melinda Gates Foundation under the framework of sanitation for the Urban Poor project (Stimulating Local Innovation on Sanitation for the Urban Poor in Sub-Saharan Africa and South-East Asia).

REFERENCES