Do-it-Yourself (DIY) Workspaces Run by Local Entrepreneurs that Transform Plastic Waste Into Valuable Water and Sanitation Products

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Do-it-Yourself (DIY) workspaces run by local entrepreneurs that transform plastic waste into valuable water and sanitation products

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***Abstract*—In informal urban settlements, there is an abundance of plastic waste material, which creates a range of health and environment-related problems. At the same time, there is a lack of locally produced products to improve the conditions for basic needs such as water and hygiene. As a means to connect these two challenges, we propose a distinctive solution in this paper: Do-it-Yourself (DIY) workspaces run by local entrepreneurs that transform plastic waste into valuable water and sanitation products. Our focus area during this project was the Korail slum in Dhaka. With the support of the Capability Driven Design (CDD) method, that aids design teams to systematically and comprehensively explore user contexts, we conducted an intensive field study in Korail. These insights helped us to identify fifteen product ideas, which were assessed on a range of criteria for viability. One of the worked-out solutions is a lid with vibrant colors made of recycled plastics to cover the aluminum pots used for storing water. Consequently, a lid and corresponding mould for local use with the plastic recycling machines of Precious Plastics were developed. The team also developed a business plan that is embedded in the network structure of the community and can be adopted by local entrepreneurs. The uniqueness of our approach lies in valorizing the use of local waste materials for products related to basic needs by stimulating DIY and grassroots level entrepreneurship.**

Keywords— Plastic Waste, DIY, Bangladesh, Informal Settlements, Water & Hygiene, Entrepreneurship

I. INTRODUCTION

A. The DELTAP project

The DELTAP project is a joint faculty research group from the TU Delft and partners in Bangladesh and India, searching for an integrative approach for safe drinking water supply in the Ganges-Brahmaputra-Meghna Delta. Part of this project focusses on the creation of products by local entrepreneurs using local materials via Do-It-Yourself (DIY) practices, with the intention to solve local water and hygiene problems. The focus is specifically on using plastic waste as a material source, as this is a pertinent source of environmental pollution in urban informal settlements and present in abundance. For this study, we selected the Korail slum in Dhaka (Bangladesh) as our focus area for exploration and potential implementation.

B. Water, hygiene and waste challenges in Korail

The Korail slum is one of the biggest informal settlements in metropolitan Dhaka with a population of about 150,000 spread over 586 acres of government land. It is shaped like a peninsula, surrounded by lakes on three sides [1]. High population density without established formal services typifies this settlement. The majority of households are tin-sheds often sharing a single cooking place and a shared cemented pit or hanging latrine for sanitation [2].

As with any other urban informal settlement, Korail has a wide range of societal challenges amongst other related to water, hygiene and waste. As the population of Dhaka is growing with 5% each year, the city struggles for sufficient and clean drinking water. The main source is groundwater which is depleting rapidly as the abstraction exceeds the recharge rate, and the surface water around Dhaka is highly polluted [3]. As a consequence, the lack of access to sufficient and safe drinking water is affecting an increasing number of people. The most affected people are the ones in the slums. Another concern in slums is hygiene. According to a research of UNICEF most slum dwellers are aware of hygiene rules, but they do not put them to practice [4]. With the local Gulshan-Banani Lake on the southern and eastern boundary, Korail slum is especially prone to water-borne diseases. Waterlogging following severe rainfall is also common, which also increases hygiene problems.

In such urban informal settings, a significant percentage of the population has zero access to proper waste disposal services, which in effect leads to the problem of waste mismanagement [5]. The total waste collection rate in major cities of Bangladesh such as Dhaka is only 37% [6]. Without proper collection system, the waste is illegally disposed of, which poses serious environmental and health hazards to the local population. The waste stream in Korail, has an abundance of plastic waste material which creates a range of specific problems such as diseases, clogging of the sewage system and water pollution. Only a small portion of the plastic waste gets re-used or recycled (mainly the larger and cleaner parts like PET bottles).

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In the past years, different projects have been deployed to create better-living circumstances in the Dhaka slums. However, such measures have frequently failed to incentivize a change in hygiene habits of the inhabitants. For instance, placing garbage bins does not necessarily prompt people to use them. The inhabitants are not used to throwing their waste in bins and still continue to throw it into the surroundings (See Fig. 1) [7].

Fig. 1. Waste in Korail slum.

As a means to connect these challenges (plastic waste, access to safe water, and hygiene), in this paper we propose a distinctive solution: DIY workspaces run by local entrepreneurs that transform local plastic waste into valuable water and sanitation products. In this way, we do not only bring about a bottom-up solution to the plastic waste and basic needs, but we also foster local entrepreneurship (See Fig. 2).

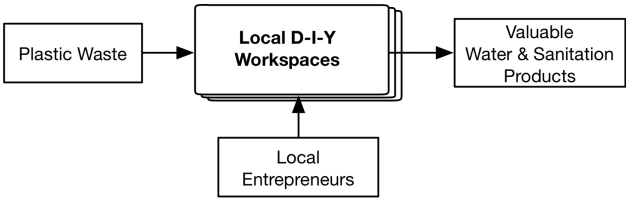

Fig. 2. Project challenges.

The intent is not to scale and recycle every waste product that is generated, but rather to reduce wasteful littering in urban slums and to educate the local community of the possibilities of waste.

C. Do-it-Yourself and Precious Plastics

The term 'DIY' usually refers to practices that involve making of goods for self-consumption utilizing tools and materials from the surrounding [8][9]. These practices revolve around innovative make-do products (systems) born out of poverty to economically solve basic problems with resources in the immediate surroundings. In this case, we propose local 'DIY Workspaces' in which these DIY practices can take place.

Precious Plastic is a global community with an extensive worldwide experience regarding local small-scale DIY-plastic recycling workspaces. In collaboration with Precious Plastic, we are developing a model for DIY workspaces in urban informal settlements where people can use local plastics to come up with water- and hygiene-solutions. Precious Plastic provides blueprints of plastic recycling machines and know-how on the recycling process. These machines (See Fig. 3) are based on general industrial processing techniques, but designed to be easy to build and operate by non-professionals [9].

Fig. 3. The range of Precious Plastic machines (top) and examples of produced DIY plastics products (down).

Together they can be used to set up a small-scale plastic recycling DIY-workspace. To make it possible to spread those workshops all over the world, Precious Plastic shares all information as open access (https://preciousplastic.com). On an active online forum, people (over 40.000) share their ideas and creations and help each other with all kind of problems [9]. At the moment, there are more than 250 of these recycle workshops around the world. One of the challenges for Precious Plastic that remains is to stimulate communities to go beyond the existing designs and start to self-design and self-produce products that fit their local (basic) needs. Another challenge is to apply this concept in the specific context of urban informal settlements. Both challenges of Precious Plastic are aligned with the previously stated objectives of the DELTAP project and the societal challenges in Korail slum. As such it was decided to take the open source plastic processing machines as one of the basic ingredients of the to be developed DIY workspaces.

D. Design brief

Based on the DELTAP project objectives, the problem setting of the Korail slum, and the opportunities provided by the previous experiences of Precious Plastic, the following design brief was defined:

"Identify opportunities for Do-It-Yourself Workspaces based upon Precious Plastic recycling machines run by local entrepreneurs that transform local plastic waste into valuable water and sanitation products. Work out one or two product solutions from recycled plastic as well as business plan to demonstrate the concept."

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II. Research Approach

The research approach consisted of three stages: 1) Preparation, 2) Field research, 3) Product-Service System Development [10]. The goal of these stages and the activities carried out during these stages are described below. This paper focuses on stage 2 & 3, as such the description of the 1st stage of research approach will be kept short.

A. Preparation

The goals of the preparation stage were (a) to obtain an understanding of water, hygiene and waste challenges in Korail, and (b) to learn more about the possibilities and challenges of working with Precious Plastic machines and recycled plastics.

For the first part, getting an understanding of the challenges regarding water, hygiene and waste, a literature review of scientific articles, reports, and documents of studies related to Korail slum was executed. For the second part, explorative plastic recycling experiments with Precious Plastic machines were conducted. In order to get a good understanding of recycled plastics as a material, a range of experiments was done in line with the Material Driven Design (MDD) method [11]. MDD supports the design of meaningful material applications with the material as a point of departure. Iterative 'tinkering', an essential part of MDD, was conducted to search for valuable material properties of recycled plastic samples created with the Precious Plastic machines. Tinkering in this case means playful, iterative explorations with new materials in order to get a better understanding of (un)expected material characteristics, with the aim to further improve them as well as to get ideas for applications.

Since the Precious Plastic machines can create a high variety of plastic appearances (for example by different plastic mixes and/or pressure), 'tinkering' created a rich variety of samples (See Fig, 4). The tinkering process was not only done for getting insight in the materials properties, but as well as for preparing a range of material samples for the field research to test the acceptance by the Korail inhabitants of recycled plastic in relation to water and hygiene product applications.

Fig. 4. Recycled plastic samples prepared with Precious Plastic machines for the field research.

B. Field research

An intensive field research for Korail slum was prepared with the objective to obtain detailed insights in (a) perception and management of (plastic) waste (b) practices and values related to water and hygiene in their daily life (c) practices that can be improved by new plastic products and (d) perception of the use of recycled plastic for water related products. This field research was carried out in close collaboration with the local NGO Environment and Population Research Centre (EPRC). To cover the first three objectives rapid ethnographic techniques were used. Rapid ethnography is mainly meant for collecting and analysing cultural data [12] and can be conducted in many different ways and comprises different methods. For this research, the by TU Delft developed Capability Driven Design (CDD) method was selected as a guideline for the ethnographic field research [13, 14]. The CDD method is developed based on the domains of Human Centered Design [15], Design for Development [16], Rapid Ethnography [17], and Sen's Capability Approach [18, 19]. It urges designers to obtain comprehensive user insight, and in this way move beyond the investigation of product–user interaction. It supports them to efficiently and rigorously explore their potential users' context and valued beings and doings. By using this approach, design engineers are guided to make informed design decisions and to improve the accessibility, applicability, acceptance and adoption of the technologies that they develop. During the field research the steps of the CDD approach were followed: preparation in the Netherlands (step 1), informal observations and talks to obtain informal insight (step 2), semi-structured interviews to obtain deep insight (step 3, using the tools from the Opportunity Detection Kit, which is part of CDD) and focus group sessions to validate the findings (step 4).

In collaboration with EPRC, participants from different Korail neighborhoods were invited. Korail slum was dived into five areas in order to ensure that all neighbourhoods were represented. For the interviews, from each area one male and one female participant was selected. For the focus group sessions two female and two male participants were selected from each area. This resulted in one focus group session of 11 female participants and one session with 10 male participants.

Observations: Informal observations were planned to obtain a better understanding of the context and more specifically of the perception and management of (plastic) waste (field research objective a). The observations were focused on how people live and behave in general, and more specifically on which production systems are in place, what people currently already produce locally and what kind of tools are available. It was also investigated what kind of plastic waste is available. The type of plastic waste is relevant, as this has a big influence on the products produced by the Precious Plastic machines

Semi-structured interviews: The CDD approach comprises 24 themes with several conversation topics per theme, based on lists and dimensions from literature, field reports, and experience. The ODK supports semi-structured interviews with timelines (which can be used to let the interviewee draw his daily, monthly and/or yearly routine), as well as a range of 'interview topic cards'. These cards guide designers in establishing a dialogue. In order to further guide the dialogue between the designer and the participants, for each theme

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questions and example pictograms have been developed. The questions are based on Nussbaum's [20] capability definitions, and on the questions developed by Anand [21]. For the field research in Bangladesh, the pictograms were adjusted to the local cultural context in collaboration with EPRC (See Fig. 5).

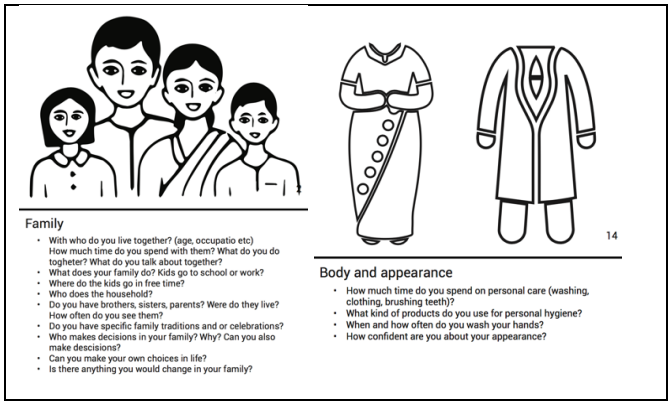

Fig. 5. ODK topic cards for semi-structured interviews adjusted to the local context.

An employee of EPRC with experience in interviewing and who was trained to use the approach and tools conducted the ten interviews. Every day, the interviewer conducted two interviews in one of the five areas. Answers to closed questions were filled in on a form and the answers to open questions were first written down in Bangla and later translated into English. From this, the conducted interviews were decoded by the research team into one big processing sheet. With this process sheet, the findings were analysed and summarised, to result in a selection of facts relevant for this research.

Focus groups: After the conducted semi-structured interviews, two focus group sessions were executed. On the advice of EPRC the male and female participants were split into different groups. The topics of the sessions were chosen based on the most relevant and interesting findings of the conducted interviews. The topics were focussing on relevant values, water, hygiene and plastic waste. An EPRC interpreter, who directly translated the discussions to the research team, conducted the focus group sessions. This enabled the research team to directly react on what was being said. Both sessions took two hours. The focus group session results were described by topic and discussed with EPRC and within the research team to provide input for the product-service system development part of the research.

To complete the last objective of the field research: 'perception of the use of recycled plastic in water-related products', during the focus group sessions a materials experience session was set up. For this session, a variety of recycled plastic samples produced during the preparation phase was selected based on their appearance (colour, pattern, shape, size, thickness and texture). First, the performative qualities were researched by analysing how the participants touched, studied, and discussed the objects. Moreover, a material ranking exercise was conducted, within the following categories: general appeal, colour, and cleanness. During the ranking, the participants were asked about the reasons behind their ranking choices and about their general opinion of the colours and shapes of the different samples.

C. *Product Service System Design*

The third and last part of the research approach was the development of a Product-Service System (PSS) [22, 23] for the proposed Do-It-Yourself Workspaces that transform plastic waste into valuable water and sanitation products. Based on the insights gathered during the field research two promising product directions were identified by the research team and further developed and validated in the field. In addition, moulds for production in the DIY workspaces were prepared. The team also developed a production system and business plan that is embedded in the network structure of the community and can be adopted by local entrepreneurs.

Due to the focus of this paper, we will only report on the results of part B (Field Research) and part C (Product-Service System Design).

III. Results From Field Research

This section reports the combined findings of the interviews, focus groups and observation. First, the important values, waste management, and water contamination will be discussed. Next, the findings on the type of plastic waste, production facilities locally available, and the user experience with the plastic samples are summarized.

Important values: From the fieldwork, it became clear that children's' future, family and community are important values in the lives of the participants. The male participants wanted to add work since work supports their family and the future of their children. Both groups mentioned sending their children to school as the most important factor for realizing a better future for them. The female group indicated a healthy lifestyle by proper food and hygienic practices to enhance good health. The men were mainly talking about a good and safe living environment: an environment without crime and with proper facilities.

Neighbours are important in the lives of the participants. The community checks on each other and makes sure everybody is doing well. Where the women saw their neighbours as friends, the men described them more as brothers: not as close intimates, but good to have them as nearby company. The women claimed that the community made it possible to create legal water supplies. They want to do the same regarding electricity and gas. The men were mainly talking about the threat of the government wanting to evacuate the slum. They said the community should discuss their preference for staying in Korail with the government. They also argued that if evacuation is inevitable, that the government should provide other living opportunities.

Waste management and pollution: Both groups claimed to be aware of the pollution caused by illegal waste disposal in their surroundings. The men claimed it already improved a lot, making it more difficult for them to see that the area is still

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extremely polluted. The female group shared that they are responsible for cleaning their surroundings but that it is hard to control the disposal behaviour of other people.

There is a community organized waste collection system established, which already helped a lot. Both groups explained that the community waste service does not cover the whole slum, as not everybody was willing to pay 50 BDT (~€0.50) per month for waste collection. The male group argued for the Dhaka City Corporation to take care of the waste management, and otherwise the community should ask for more rickshaw vans for waste service and for more dumping sites.

Both groups reported that big plastic products that break down are mostly sold to shops or thrown on the streets, knowing that waste pickers will collect the big products from the streets, since it provides them with some income. Small plastic packaging is mainly thrown away with household waste, directly on the streets, or directly at the shops. The participants shared that they think small waste is not so harmful for the environment. This small waste disposal is a known phenomenon in BoP countries, caused by the 'sachet economy'.

The slum dwellers do have some awareness about pollution of the environment. However, people do not bother about the environment because other problems are more pressing. Finding a proper incentive to clean the environment and properly dispose of waste is therefore an important target for the to be developed Product-Service System.

Water contamination: Polluted drinking water is a cause of many illnesses such as skin diseases and stomach problems. Participants who had lived in rural Bangladesh knew about arsenic contamination in Bangladeshi groundwater, but they claimed that arsenic poisoning is not affecting Korail slum. The participants indicated to boil their water for at least 10 minutes to kill germs, which also results in iron sinking to the bottom which, makes it easy to separate the iron from the water. Filtering with cloth is sometimes done at hand pumps and sometimes after boiling, when the water is poured into aluminium storage pots. Filtering with cloth only removes iron and dirt as both groups explained. In the male focus group it was argued that a hand pump filter would be nice, and that, if the filter is used and shows the benefits, other people would be willing to buy it as well. The filter should, according to them, remove bacteria and dirt. The men indicated that water filter machines are the best option for cleaning their water but that they are too expensive for the inhabitants (4000 BDT, ~€40).

Aluminium pots are used for water storage as they do not impart a smell. Both groups were interested in a lid to cover the aluminium pot since they now they improvise with whatever can find (See Fig. 6). The men were interested in an integrated filter in the lid but the women did not really see the benefits of this.

Different inhabitants have different ways of using and storing the water. All the water supply in the slum area is connected to piped water systems. Some people connect hand pumps with a motor to the system, while others have taps or open-ended pipes with motors. Filtering the water is also done in different ways. This became clear during the focus group session: one male participant claimed that he always drinks water straight from the tap and never had any diseases. The other participants claimed that this is unwise and water should always be boiled before drinking.

Fig. 6. Aluminium storage pots with dishes as lids.

Hygiene: Both male and female participants agreed that soap should be stored in a hygienic place. The participants however, indicated to not need soap storage solutions because they exist already. Both groups claimed they wash hands after latrine use. Some men claimed that they sometimes forget to use soap. The women reported that from the age of three children are taught to use the latrine, but that they often still need help as the water container for flushing and washing is too heavy.

Plastic waste available: While analysing the waste in Korail, several types of products and plastics stood out. Since the PET bottles are widely collected by tokai (rag pickers), the PET bottles are not commonly found on the ground. LDPE bags, styrofoam and a lot of multi-layer sachets were detected (See Fig 7.). The polypropylene products like baskets and chairs were mainly disposed of on the streets or sold to waste pickers. Polypropylene was one of the materials that the waste pickers collected. The waste pickers claimed that they sorted plastics by type but they could not tell which types of plastics they pick. Thereby, different types of plastic were spotted in their bags.

Fig. 7. Boat made from styrofoam and other plastic waste and polluted water.

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Production facilities: During the visits to the slum, many repair shops for rickshaws, bed making workspaces and other workshops and stores were found. The main tools for making the Precious Plastic machines (welding machines, angle grinders, saws) were found inside the slum area. Companies or workspaces that can make laser cut parts were, difficult to find. Thereby, sourcing all the parts for constructing the machines will also be more difficult.

Materials experience: Figure 8 visualizes the material 'rankings lists' of the two focus groups (See Fig. 9) on general appearance, colour, and cleanliness. The samples are ranked on average ranking.

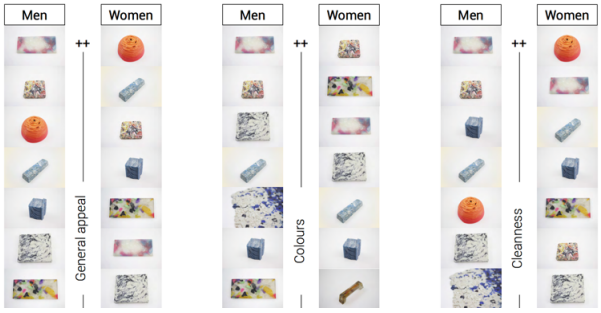

Fig. 8. Plastic sample ranking by men and women on general appeal, colours and cleanliness.

As visible in the lists, the men and women focus groups had different opinions about the overall best sample, preferred colour and cleanest look of the materials. This result cannot be generalized, as there were only two groups of people, but with the additional conversations and experiental sessions some interesting facts became clear: The slum inhabitants did not link colour to certain emotion or value. They mentioned that they did not value black colour in products of hygiene. They also preferred material samples with different colours spread out in the sample. When it came to translucency the participants were divided. Especially the men did not like the translucent materials, but the women did favour them. The participants were most interested in flowy, colourful samples. This fact is consequently considered during the design process. Since the product directions will be created around water and hygiene related topics, the materials should evoke certain cleanliness. After looking into the cleanliness ratings, samples with a smooth surface with spread colours, or rougher surfaces with one colour were rated the highest. Roughness and translucency were rated low.

IV. Results From Product Service System Design Development

The field research provided rich insights into the different topics related to the development of DIY workspaces run by local entrepreneurs that transform plastic waste into valuable water and sanitation products. In this third phase of the project the product-service system was developed. This process started with the development of the recycled plastics products, selecting the proper Precious Plastic machines, and detailing the moulds, and was followed by the business plan development.

Fig. 9. Materials experience session with the female focus group.

A. Generating and selecting product ideas

The interviews resulted in an initial range of product directions, which were validated during the focus group sessions. In addition, the research team identified another set of product ideas derived from the data analysis of the fieldwork. In total, 15 product ideas emerged from the field research, which were assessed on a range of viability criteria. In total, 21 assessment criteria were used, which were classified in the following 5 domains:

- Waste (5)
- Technical (5)
- Impact on water & hygiene related problems (2)
- Acceptance by user (7)
- Material experience (2)

After evaluating all 15 product ideas by these assessment criteria, two product directions with the highest ranking were selected: A) A lid for water storage pots, B) A water filter for dirt after boiling.

The first product direction was worked out into a detailed product-service system. A range of insights derived from the field research contributed to the solution of a lid with vibrant colors made of recycled plastics to cover the aluminum pots used for storing water. People in urban slums use aluminum pots to store water, but there is no proper lid available to cover them, resulting in the usage of plates, cups, metal puts, melamine plates, wooden planks or no coverage at all. Due to the ill fit between the aluminium pot and the improvised lid, water gets polluted. It was further observed that smaller plastic waste parts are not perceived as harmful and hence, not recycled. Moreover, community members indicated during the participatory sessions that they favored the recycled plastic samples with vibrant colors. Consequently, a lid and the corresponding mould for local use with the recycling machines of Precious Plastic were developed. Lastly, the locally available tools and materials were considered for the mould design. This will be discussed in the next section.

B. Product and DIY production development

The development of the lid, the detailing of the mould and the selection of the proper Precious Plastic processing machine are all closely interconnected and influenced by each other

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(See Fig. 10). For example, the selection of the type or processing machine has direct impact on the product and mould design: with the experience obtained during the tinkering experiments of the preparation phase, the Precious Plastic injection machine was chosen as the most suitable machine for the production of the lid. During the experiments with the injection machine, it was found that thin walled objects need a high pressure and therefore, a lot of injection force. Taking into consideration the pressure that can be built up in the DIY Precious Plastic machines, the lid preferably cannot be thinner than 5mm (limitation of production process). In addition, the injection provides a still a serious pressure, which can easily deform the mould. Consequently, the mould should be strong enough and be made preferably of 5 mm thick steel (sheets). If not available, the mould should be reinforced with additional L-profiles to avoid bending.

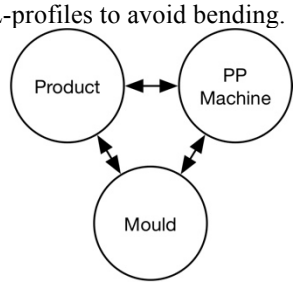

Fig. 10. Close connection between product design, mould design and type of Precious Plastic processing machine.

The moulds should be easy to produce (and if needed adjusted) by local entrepreneurs with locally available equipment. During the observations in the field research a list of available techniques was created: welding machine, drill, angle grinder, hand tools like hammer, saw etc. For easy moulding, the products should be tapered, or at least should not have overhanging parts. This requires multiple part moulds, which are more difficult to design and to create, but results in easier lid production.

The middle plate, the actual shape for the lid, was created by a lot of grinding with the angle grinder. For this process, a metal jig-saw can also be used. Since the angle grinder is widely used in Bangladesh, it was chosen to prototype with this tool. It resulted in a long process of slowly creating a hole of 15 cm in diameter. The handle is made by adding a small tube to one of the plates (See Fig. 11).

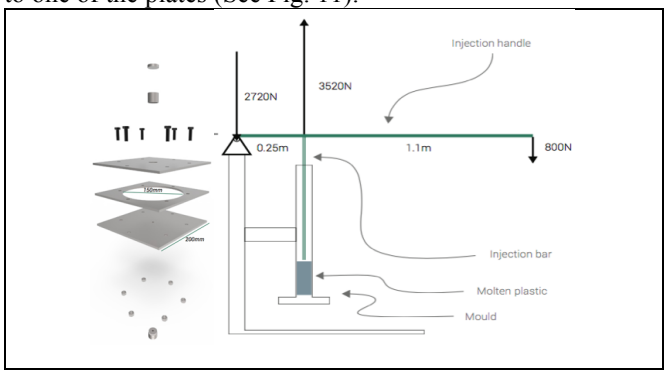

Fig. 11. Details of developed mould (left) and the Precious Plastic Injection machine (right).

With the injection machine, it is possible to use HDPE, LDPE and PP. These materials are widely available in Korail slum. The source material should be clean, and therefore the waste is preferably collected from the source or brought to the shop (to avoid extra contamination). Thereby, the material should be separated by plastic type. Since the Korail slum inhabitants did like flowy colours, the plastics do not need to be separated by colour.

Next, the mould was used to produce a series of lid prototypes in different colours with the use of a Precious Plastic injection machine (See Fig. 11). With these prototypes, user tests were performed both in Korail slum and in rural areas in Manikganj and Narail (See Fig. 12).

Fig. 12. The developed lid and validation in Bangladesh

These validation tests were focussed on the material experience and acceptance of the product by potential users. The lid received positive appraisal. Local people mentioned that it was nice looking and also emphasised the lack of proper lids available currently. The lid colour they liked the most was a vibrant red one with a lot of colour contrast. It was stressed that the lid should be “really cheap”. Some women asked if they could have, buy or create them.

C. Product-Service System

The team developed a business plan that is embedded in the network structure of the community and can be adopted by local entrepreneurs. Since there are many different ways to implement the DIY workspace into an area, three scenarios have been illustrated. Each scenario has a different way of waste collection, production and distribution and therefore all have their strengths and weaknesses. It still needs further investigation of which scenario will be most suitable to Korail slum.

Centralized system The first product-service system is based on the existing Precious Plastic pilot workspace in Kisii, Kenya. The idea is to collaborate with one of the many active NGO’s in Dhaka to create a workspace where people can come with their waste and create their own products. For this, supervisory staff from the NGO is required to help and instruct the consumers.

Central collecting and selling point This production system focusses on a central collecting point of plastic waste, in this case a shop where water storage pots are sold. People can get a small amount of money or discount on delivered plastic

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waste. The waste is shredded and processed into new products and people can buy them again. If pots are sold in a shopping street, other shops can bring their waste to there as well.

Rickshaw selling This production system is based on the community based waste collection. The waste collectors can bring the plastic to a specialized place where people own all one particular machine with which they all contribute partly to the full production process. This enables scalability of the production system. The products can be either sold in shops or by the waste-rickshaws. The rickshaws cover most of Korail and come in contact with many inhabitants.

V. Discussion

Within this research project, we have been bringing several societal challenges within urban informal settlements together. The uniqueness of our approach lies in valorizing the use of local waste materials for basic need products by stimulating DIY and grassroots level entrepreneurship. By linking several societal challenges, more comprehensive solutions can be identified, with an expected higher local societal impact.

The project has also a range of limitations. Even though an intensive field research was carried out, still only 20 people were interviewed and 2 focus group sessions have been held. More interactions with the community will be needed to further develop this initiative. With regard to testing and validation: the developed product (lid) has been validated in Korail. The production still took place in the labs in the Netherlands. A next step is to set up a DiY workspace locally in Korail.

The lid was only one product, slum dwellers are most expectedly creative by nature and are likely to indigenously design and manufacture other objects of need using the know-how of plastic recycling. And as such creating more opportunities to transform waste into valuable products.

Lastly, in this part of the DELTAP project, water quality parameters of the source water are not taken into consideration, the focus is on safe supply from tap / pump to mouth, and therefore solutions have been sought for challenges in storage and the actual supply. Integrative solutions for ensuring good quality of the source water are investigated by another part of the DELTAP project.

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