



DESIGN & DEVELOPMENT OF A DISABILITY INCLUSIVE SANITARY SYSTEM USING ADDITIVE MANUFACTURING (3D PRINTING) FOR PROTOTYPING

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PROBLEM STATEMENT

Nigeria, with an estimated 48 million residents practicing open defecation as of 2020, is one of the countries with the highest rates of unsafe defecation globally (UNICEF 2020). Open defecation is detrimental to the health and well-being of the general population, particularly children, girls, and the disabled who usually have special needs and supports to use toilets, especially in rural areas of Nigeria, having 79% using the pit latrine system and 21% using the water closet options. In 2018, the National Council on Water Resources prioritized the creation of a roadmap for ending open defecation in the nation in response to the reported sanitation crisis.

METHODOLOGY

Disability Inclusive Latrine PAN (DILPAN) is a modified pit-latrine system that simultaneously addresses Water, Sanitation, and Hygiene and offers users a hygienic and inclusive toilet solution. DILPAN is designed to be installed on the existing pit latrines, and its features help improve hygiene and enhance accessibility and inclusiveness. The system is based on a self-closing mechanism (trapdoor) that prevents odours, flies, and other pests in the pit from gaining access to the pan and consequently minimizes the spread of diseases. The trapdoor opens when faeces are dropped on the door, allowing the waste to go into the pit, and closes when no load is placed on it. During flushing, a minimal amount of water cleans the pan and opens the trapdoor. This conserves the volume of water required for flushing.

Technical Description

DILPAN is an improved latrine system for use in rural areas and refugee camps. This innovative technology is designed to be installed on existing pit latrines. Its features (see Figure 1) help improve hygiene and enhance accessibility and inclusiveness. The main features are briefly discussed below.

a) Self-Closing Trapdoor: The self-closing trapdoor (Figure 1c) is located at the bottom of the DILPAN. It prevents odours, flies, and other pests in the pit from gaining access to the pan and consequently minimizes the spread of diseases.

The trapdoor works on a self-closing mechanism such

that it opens when faeces are dropped on the door, allowing the waste to go into the pit. The trapdoor closes when no load is placed on it (which is the system's ground state). The trapdoor is designed such that the weight of the faeces is always more significant than the restoring force of the spring-based mechanism. During flushing, a sizeable amount of water cleans the pan and opens the trapdoor. This conserves the volume of water required for flushing.

b) Plastic Handrails: The handrails are included for those with a crippling disability. It makes access to the DILPAN easier for wheelchair users. It also enhances comfort and posture when making use of the facility.

c) Funnel-like Faeces Pathway: The pathway was designed to take the shape of a funnel which allows easy passage of faecal matter into the DILPAN.

d) Wash hand basin: A wash hand basin, an extension of the plastic-based sanitary system, is designed for washing hands as a way of promoting hygiene among the target population. It is connected to a container via a pipe.

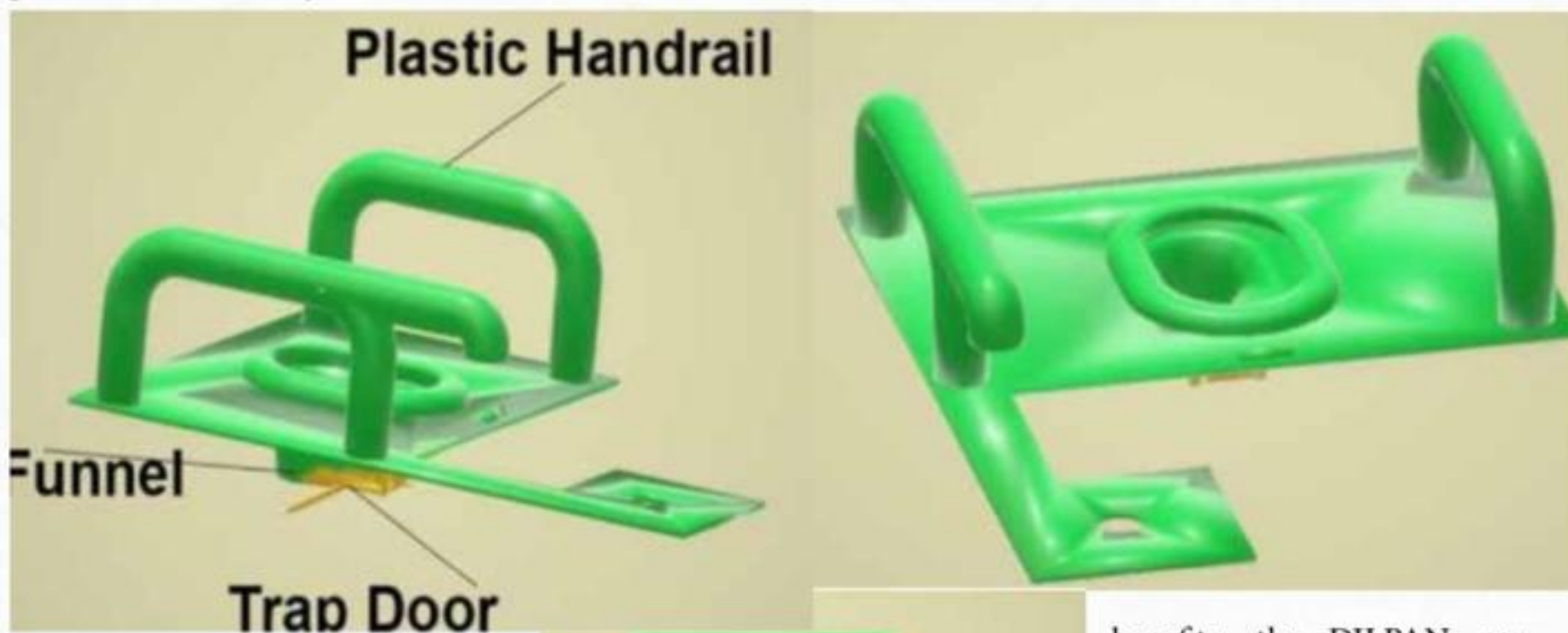
e) Retractable Seat: A seat to make the DILPAN comfortable during usage.

f) Vent: A vent made of plastic pipes is incorporated to allow the escape of odour from the pit into the air at a higher altitude. This is to prevent the accumulation of gases that could pose a health risk to users when the trapdoor opens for use.

g) A tissue paper holder is designed as an extension of the handrails

DESIGN

DILPAN has its design rationale, which includes accessibility, cost, and ease of production. The latrine system was designed with plastic hand support for people with disability, a trap door to avoid infectious disease transmission from the interface to the user, and a hand wash apparatus for reducing the risk of infections after using the toilet. All these were considered as part of the accessibility criteria to the target audience, which includes people with disability, children, and the girl child. A prototype was developed at a total cost of ₦6,200 with additive manufacturing, a rapidly growing technology that has revolutionized the manufacturing sector. The materials for production are readily sourced materials.



RESULT/ NOVELTY

The project offers an innovative design to enhance access to a simple sanitation system. The solution has an inclusive design that makes toilets more accessible to everyone, including marginalized groups.

The proposed solution is affordable for people living in marginalized communities. In addition, the innovation offers ease of production using readily available local materials.

DILPAN helps reduce disease transmission, provide safe sanitation facilities and improve the quality of life for residents of Nigeria who utilizes open pit latrines. This cost-effective DILPAN used ingeniously simple mechanical and water seals with a trapdoor mechanism to close off the pit from the open air, thereby preventing flying insects from spreading pathogens from contact with human waste. In addition, using the DILPAN allowed residents to continue “flushing” their waste using their traditional water containers.

The project can be fabricated from plastic (PVC), hinge joints, and flexible springs. Plastic can be obtained from local plastic manufacturers, while joints and springs can be acquired from local producers.

VALUE ADDITION/IMPACT

The design addresses the challenges of open defecation in Nigeria. The plastic design is cheap and acts as an effective seal over the toilet. In addition to the sanitary



benefits, the DILPAN pan also serves as a primary safety measure. Because of the nature of some open-pit latrines, young children risk falling inside.

Preserving the environment is critical for humankind. At the DILPAN Group, we recognize

that sustainable corporate activities are essential, and we are committed to reducing the environmental impact of our business by offering environmentally friendly products and services. Furthermore, our policy is to achieve harmony with the environment throughout our business.

APPLICATION

The pan's design allows for potential variations according to local customs and demands, such as using the facilities by squatting or sitting or adapting to the pit's shape for the latrine. However, the core concept around which the pan is based is the counterweighted “flapper” itself. The counterweight is set explicitly so that the flap remains closed until the force of water/faeces act on the pan. The pour-flush mechanic also creates a liquid seal, with minimal water remaining on top of the flap after use to help prevent the transmission of insects or gases. This approach, utilizing a primary mechanism while leaving room for responsive adjustments in design, allows the DILPAN to be adapted globally while maintaining a simple but effective means of providing essential health benefits.