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Innovative Fibreglass Mobile Sink Basin: An Intervention for Hand Washing in an Era of Pandemics

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The purpose of the study was to undertake an innovative project of producing a mobile sink basin from fibreglass as an intervention for hand washing in Ghana. The qualitative research approach with the arts-based descriptive research design guided the study. Fifty-five (55) study participants in the Kwame Nkrumah University of Science and Technology, Ghana were purposively sampled to evaluate the project in the context of handwashing in this era of pandemics. Data were primarily gathered via semi-structured interviews, observations and photographs. Detailed account on the tools and materials as well as the procedural steps for the production of the innovative fibreglass mobile sink by meticulously following the rules in arts-based descriptive research design. The

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qualitative data were analysed using the qualitative thematic analysis. The study found that the fibreglass mobile sink would be useful for handwashing and proper hand hygiene at homes, schools, healthcare facilities, workplaces, and marketplaces to prevent the spread of infectious diseases. In the face of the global COVID-19 pandemic and future pandemics, the study suggests the scaling up of this innovative mobile sink due to its convenience, cost-effectiveness, accessibility and portability that would encourage the Ghanaian citizenry to practice handwashing. The study recommends that the Ghana government via the Ministry of Health in Ghana should seek for funding avenues to support the mass production of this innovative project. Also, the Ministry of Health must collaborate with higher education institutions in organizing and funding projects of staff and students targeted at arresting the daunting health-related issues such as handwashing to curb the spread of infectious diseases.

Keywords: Fibreglass; handwashing; hygiene; mobile sink basin; infectious diseases; pandemics.

1. INTRODUCTION

“Infectious diseases continue to be a major problem in developing countries. In the developing world, the leading infectious causes of death are respiratory tract infections, diarrheal diseases, tuberculosis, malaria, and AIDS, which together represent 90% of deaths with the remaining 10% attributed to tropical diseases and various other infections.In relation to the causes of fatalities among people, falciparum malaria is more serious in older patients and demonstrates that clinical surveillance networks are capable of providing quality data for investigation of rare events of diseases” [1,2]. “Hands are an essential element of the human body. The majority of daily actions are carried out using one's hands. Infections are most commonly transmitted through the hands and fingers. During our regular activities, our hands come into contact with objects that have been contaminated with numerous germs. Transmission of hand-borne illnesses is responsible for auto-infection via the fecal-oral pathway seen in threadworm infestations or through food handlers. Even if it does not appear so, hands become soiled. If we don't wash our hands frequently, microscopic bacteria and viruses can attach to them and make us sick. Hand hygiene interventions can help to promote equality and empowerment by allowing women, girls, and individuals with disabilities, older adults, and other groups to take on new leadership roles rather than being passive recipients of predesigned interventions. This is vital and has a direct impact on many people; for example, children and adults with disabilities account for an estimated 15% of the world's population. Over 15% of people worldwide have some type of disability, and of those, 2-4% struggle significantly to function. UNICEF is urgently seeking funding and support to provide basic water, sanitation, and hygiene facilities to more girls and boys, especially those children who lack access to safe water due to living in remote locations, areas where the water is untreated or polluted, or because they are homeless, living in slums, or on the streets” [3].

“Making hand washing programs and policies inclusive and respectful of all individuals, on the other hand, does not happen by accident. It necessitates purposeful effort and the involvement of certain groups. Programs must prioritize equity, which includes designing and situating hand washing facilities that are accessible and user-friendly to all. According to the WHO/UNICEF Joint Monitoring Programme, 31% of schools educating roughly 570 million children globally lack access to safe drinking water. Potable water is not provided in about half of the schools in Sub-Saharan Africa. More than 620 million students worldwide do not have access to basic sanitation at school, and 900 million do not have access to basic handwashing facilities at school” [3].

“School children's health and academic outcomes suffer as a result of a lack of washrooms and hygiene education. Widespread health consequences, such as diarrhoea, intestinal worms, and respiratory infections, contribute to school absenteeism and increased drop-out rates, whereas having handwashing and water and sanitation services in schools has been shown to result in a significant improvement in school attendance and teacher-pupil interaction time. The project was implemented by: Ministry of General Education, USAID and SPLASH” [4,5]. “Hand hygiene messages should be delivered in a way that includes those who have difficulty seeing, hearing, understanding, or moving, and handwashing pictures should reflect the genuine diversity of communities” [6]. “Handwashing support actions can begin before a kid is even

born by installing a handwashing station, which sets the foundation for the child's early handwashing. Handwashing by caregivers as a step before picking up an infant can have a huge impact on neonatal survival and subsequent development during the neonate period (the first 28 days of life)" [7].

Micro organisms are believed to be ubiquitous, which means they can be found anywhere. They can be present in the air, soil, bodies of water, and even heated foods. As a result, they are easily transmitted from person to person. Because humans are social beings, we frequently find ourselves in public areas where pleasantries must be shared in the form of handshakes, hugs, and holdings, among other things. No single person may claim to be completely sterile at any moment because it is likely that the clothes or objects used to clean ourselves contain a number of these bacteria. In this line, the goal is not to eradicate all microorganisms, but to lower them to levels that are not hazardous to the human system. Therefore, the purpose of this study was to produce an innovative mobile sink basin from fibreglass to aid in hand washing. This easy-guide to the presentation of the mobile sink basin is to help in their possible mass production in homes, schools, laboratories, hospitality facilities, restaurants, and public bus terminals to reduce the spread of infectious diseases, especially in this era of pandemics.

1.1 Hand Washing Devices

Handwashing is defined as the vigorous and brief rubbing together of all surfaces of lathered hands, followed by rinsing under a stream of water, with a fundamental principle of removal, not killing of microorganisms [8]. Handwashing facilities in schools is one of a mechanism to achieve sustainable development goals 4 and 6 (SDG 4 and 6) in schools, to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all and to ensure availability and sustainable management of water and sanitation for all by the year 2030" respectively [9]. Local authorities are scrambling to deal with a catastrophic scarcity of medical supplies and treatment facilities as the number of COVID-19 cases across Africa rises. The World Health Organization estimates that there are not enough ventilators or ICU beds to treat the hundreds of millions of residents of the 41 African nations. Engineers, craftsmen, and inventors from all over the continent have sprung into action in an inspiring effort to help stop a serious outbreak. To enhance sanitation and hygiene in regions with the most vulnerable healthcare systems, many communities are currently coming up with creative, affordable hand washing devices. Most diseases such diarrhea and pneumonia, which are transmitted mainly by contaminated hands can be prevented by handwashing with soap [9]. Factors such as hygiene education, adequate organizational factors including the availability of handwashing materials, and strong examples from influential persons, could effectively increase adherence to hand hygiene practices and reduce the incidence of infections [10].

In an observational study, it was reported that people who lived in urban districts, with high educational levels and sufficient knowledge on infectious diseases have a high handwashing compliance rate. In addition, women are more likely to wash their hands than men after controlling for washroom characteristics and clustering effects associated with social norms [11]. In Ghana, young entrepreneurs by the name of Richard Kwarteng and Jude Osei have invented Solar Wash, a solar-powered hand-washing sink which is fitted with a motion sensor. When a hand goes beneath the tap, a flow of soapy water is immediately released. Then, a noise is emitted for 25 seconds, after which clean water is automatically dispensed for rinsing. The invention uses just a few components. It comprises of an alarm, a sink, a sensor, a faucet, a motherboard and a solar panel. Solar Wash resembles a regular hand-washing sink but works in an even more hygienic, sustainable and cost-efficient manner. While requiring no physical touch with any surfaces, all of this promotes correct hand-washing practice. In order to get his design ready for mass production, Kwarteng is currently working with industry professionals. We must not let Ghanaians and other Africans down, so we will hire a large number of people and launch this product onto the market. The illustration of the device is seen in Fig. 1.

Creatives are working together to build specially constructed taps and sinks in communities with limited access to flowing water since they are aware that simple precautions like hand washing continue to be the most effective method of preventing the virus from spreading. For instance, RISE and XYZ Collaboration built straightforward hand-washing facilities in Lesotho using inexpensive supplies. As seen in Fig. 2 below, each metal structure is equipped with two sets of plastic buckets and bowls that are spaced apart and serve as water tanks and sinks.

Fig. 1. A Solar-powered hand washing sink

Fig. 2. Double handwashing device

Similar to this, the Tippy Tap is a hands-free hand-washing gadget that was created specifically for usage in rural areas. Tippy Taps are quick and inexpensive hand-washing stations that don't require a piped water source and are constructed using materials that are typically found about the house. Dr. James Watt first popularized the Tippy Tap in Zimbabwe, where he initially used a gourd as a water container rather than plastic. The Tippy Tap has gained popularity since it was first introduced as a convenient approach to promote proper hand washing behavior in underdeveloped communities.A Tippy Tap is the most straightforward example so far and can be created for practically nothing using items found nearby. All that is needed to build one is a few sticks, string, soap and a jug or container for the water. The device is also incredibly water-efficient, using only 40ml of water on average for each wash. The Tippy Tap invention is depicted in the Fig. 3.

1.2 The Art of Hand Washing

Hands are the primary means of transmission for many infectious diseases, especially among those who live and work in close quarters, such as those in dorms, barracks, camps, gatherings, churches, and markets. Inanimate things also serve as a breeding environment for microbes, which act as a vehicle for infectious disease transmission. How important is hand washing to individuals and the nation as a whole? According to the study conducted, diseases influence the world in unequal ways. Infections cause 62 percent of all fatalities in Africa and 31 percent of all deaths worldwide [12]. At the same time, infectious diseases account for only 5% of all deaths in Europe. Furthermore, 50 percent of all food-borne illness outbreaks in the United States are the result of improper hand washing (Mead et al, 1999). The effectiveness of handwashing programs in reducing diarrhoea cases in developed and developing countries has been

reviewed recently. The results suggest that handwashing may reduce the incidence of diarrhea by 42—47%, which worldwide could reduce the number of deaths by about one million [13]. Hand hygiene is an important health-promoting act towards preventing the spread of microbes via direct contact and fecal-oral transmission [14]. In the same vein, handwashing has been recognized as a convenient, effective, and cost-effective means of preventing communicable diseases [15].

Judah et al. [16] noted that discrete behavior monitoring in a natural setting can assist determine the best interventions for altering behaviors that are crucial to public health. They identified gender inequalities in public health intervention and thus recommended that such interventions should target men and women differently. Similarly, handwashing with soap has been endorsed as one of the most effective techniques for avoiding and spreading illness in public places like workplaces or marketplaces [17]. In a public location, the danger of disease transmission is generally substantial since individuals are in close quarters and share eating places, workstations, bathrooms, and other germ-infested areas. Workplaces, whether formal (office) or informal (roadside stand), can be breeding grounds for viruses and bacteria that can survive on common surfaces for extended periods and spread between humans through direct or indirect contact [18,19]. Office surfaces have high bacterial counts, with shared spaces such as break rooms, kitchens, and toilets having the highest germ concentration [20]. Similarly, informal workplaces, such as food booths, are important sites for disease transmission [21]. Handwashing is one of the most effective ways to remove germs, reduce illness, and prevent the transfer of germs to others. Handwashing helps prevent diarrhea and respiratory infections, and it may even help prevent skin and eye diseases.

Mobile wash basin is a portable and movable sink, having a bowl-shaped plumbing fixture, used for washing hands and dishes. It has various parts as the sink, tap, soap dispenser, and the drainer. Mobile wash basin is mostly used at the hospitals, schools, laboratories, restaurants, bars and banking halls among others. Curtis and Caincross [13] suggested that hand washing with soap, particularly after contact with faeces can reduce diarrheal incidence by 42-47 percent and supported by Clasen et al. [22] that, a 30% reduction in respiratory infections is possible through hand washing. They also indicated that, several countries have launched mass media campaigns in an attempt to promote prioritization of hand washing on the public health agenda.

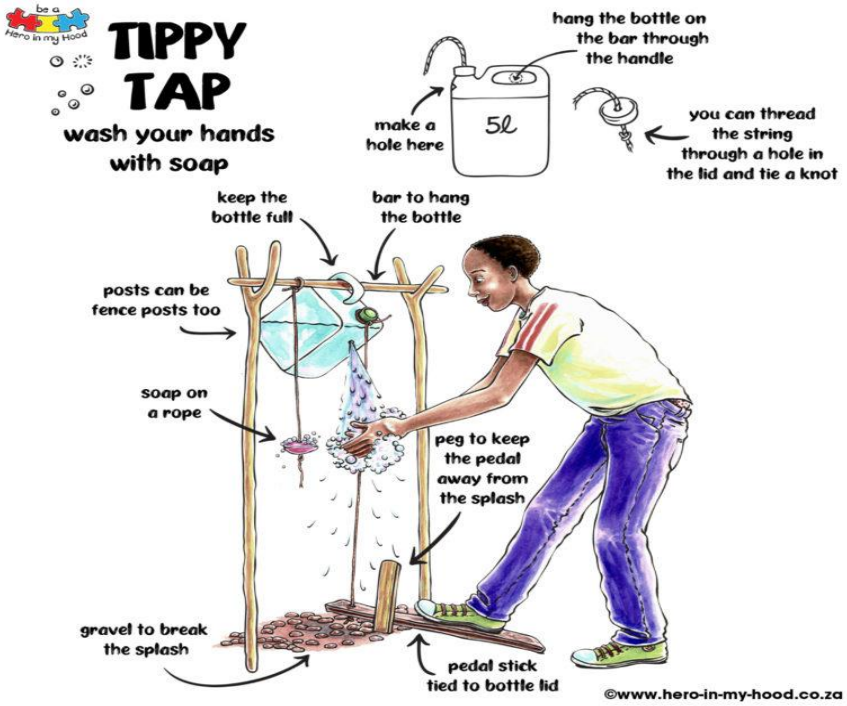

Fig. 3. Tippy Tap devices

1.3 The Application of Fiberglass as a Material

Fiberglass is a plastic reinforced with glass fibers in a resin matrix. The fibers can be stacked randomly, flattened into a sheet known as a chopped strand mat, or woven into glass fabric. The plastic matrix could be a thermoset polymer matrix based on thermosetting polymers such as epoxy, polyester resin, or vinyl ester resin, or it could be a thermoplastic matrix. Because of its radio frequency permeability and low signal attenuation qualities, fiberglass is frequently utilized in the telecommunication s industry for shrouding antennas [23]. Due to the ease with which it can be molded and coated to match existing structures and surfaces, it can also be used to conceal other equipment where signal permeability is not required, such as equipment cabinets and steel support structures. Sheet-form electrical insulators and structural components often found in power-industry goods are two further applications. Because of its lightweight and durability, fiberglass is frequently utilized in protective equipment such as helmets. Many sports employ fiberglass safety equipment, such as goalkeeper and catcher masks.

Fiberglass composites are widely used in different applications of aerospace, automotive, sports, ships and constructional work due to having higher demands. These are having many advantages due to their low cost of production, easy to fabricate, light weight, higher strength to weight ratio. Fiberglass is commonly used for reinforcing agents among different intermixing material [24]. Under tension and compression, or along its axis, a structural glass fiber is both stiff and strong. A typical fiber is long and narrow, which causes it to buckle readily, however this is only because of the fiber's long aspect ratio, which makes it appear as though the fiber is weak under compression [25].

2. MATERIALS AND METHODS

The study used a qualitative approach with a descriptive research method to provide a full description of the step-by-step process of producing a mobile sink basin with fibreglass as the main material for production. Fiberglass is less brittle, robust, and lightweight. The best feature of fiberglass is its versatility in intricate shape molding. This explains the widespread usage of fiberglass in bathtubs, boats, airplanes, roofing, and other products such as hand washing basin. The arts-based research approach was adopted for the study. The project was carried out as part of the semester project work for the academic year at the Department of Indigenous Art and Industry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. The project was fully financed by the authors of this study and supervised by the lead researcher for this paper. Because of its longevity, lightweight, inherent strength, fire resistance, and stiffness, fiberglass was chosen for the production of the artefact. Furthermore, the best feature of fiberglass is its capacity to be molded into a variety of intricate designs. Detailed accounts of the tools and materials, procedural steps and finishing of the mobile sink basin using the fibreglass have been given. The essence of the project aimed at producing an innovative mobile sink basin was based on an empirical inquiry involving 55 purposively sampled students in the Kwame Nkrumah University of Science and Technology, Ghana. The participants include thirty-five (35) female and twenty (20) male students who are in the ages between 20 to 25 years old. This study relied heavily on secondary data from recorded communication including books, transcripts, websites, newspaper articles, and journal articles [26].

3. RESULTS AND DISCUSSION

The study participants shared their views on the factors that hinder the washing of hands amongst many people in Ghana. The factors cited included negligence, unavailability of either water, soap, an appropriate place to wash hands and no vivid reasons (represented as none on the pie chart).From the pie chart in Fig. 4 below, 35.8% did not wash their hands due to mere negligence, 60% did not wash their hands due to unavailability of appropriate hand washing facilities and about 4.2% had no reason for not washing their hands. The majority of respondents (60 percent) stated that, while they would have liked to wash their hands in some places and at particular times, there was either no soap, water, or an acceptable area to do so. According to some of the respondents that belong into this unavailability category, they occasionally couldn't wash their hands after entering toilets with sinks due to the poor condition of the sinks that were accessible. This response is consistent with the findings of Borchgrevink et al. [27], who discovered that sink cleanliness influenced most people's hand washing behavior. Many people do not wash

their hands when the behavior in which they engage would warrant it. They also found that 73.9 percent of respondents would wash their hands if the facilities (sinks) were clean and in good repair. The remaining respondents gave no specific explanation for not washing their hands. They suggest that proper hand washing practices, as recommended by the Centers for Disease Control and Prevention (CDC), are not being practiced and contributes to almost 50% of all foodborne illness outbreaks. As a result, the researchers suggest that hand washing facilities, particularly outside of houses, and simple neglect on the part of participants, and possibly some persons in general, are to blame.The results can help increase hand washing rates for the general public and thus decrease the risk of transmitting disease.

Fig. 5 represents the responses as to their preference for either a bowl filled with water or a movable sink basin for hand washing. It was observed that, out of 55 participants, 39 (70.9%) participants preferred to use the movable sink, 11 (20%) participants preferred to use a bowl with water and 6 (10.9%) participants were indifferent. According to the results, the majority of study participants (94.3 percent) stated they would prefer the moveable sink, while only a few said they would stick with the bowl with water. The majority of the reasons given were those of hygiene and health. Most persons agreed that there was a high risk of cross contamination with the bowl of water, where individuals could take up microorganisms from other people during hand washing. However, with the movable sink, everyone gets to wash their hands under running water, which is more effective; so, the food code specifies that hand washing should take at least 20 seconds and involve running water [28-31]. The few folks who preferred the bowl with water did so because they were unsure how the mobile sink would work.

In an attempt to solve this concern, the researchers proposed creating an artifact that could be used for hand washing in places other than washrooms. The movable sink basin was to be developed in such a way that it could be put at various vantage points in various locales, so that those who had problems with the lack of washing facilities would no longer have that problem. Participants were asked to state the factors that hinder their interest in hand washing, their responses were captured in the illustration in Fig. 4. This manner, it can be placed wherever they can use it whenever they want. As a result, the researchers sought to determine if the respondents knew what the movable basin would look like and if they had used anything similar before. As can be observed, only a few of the respondents had used something similar in the past. It is also clear that most of the study participants were unfamiliar with movable sink basins and how to use them. As a result, if the mobile sink was manufactured, there would be a great deal of sensitization and education on its use and benefits.

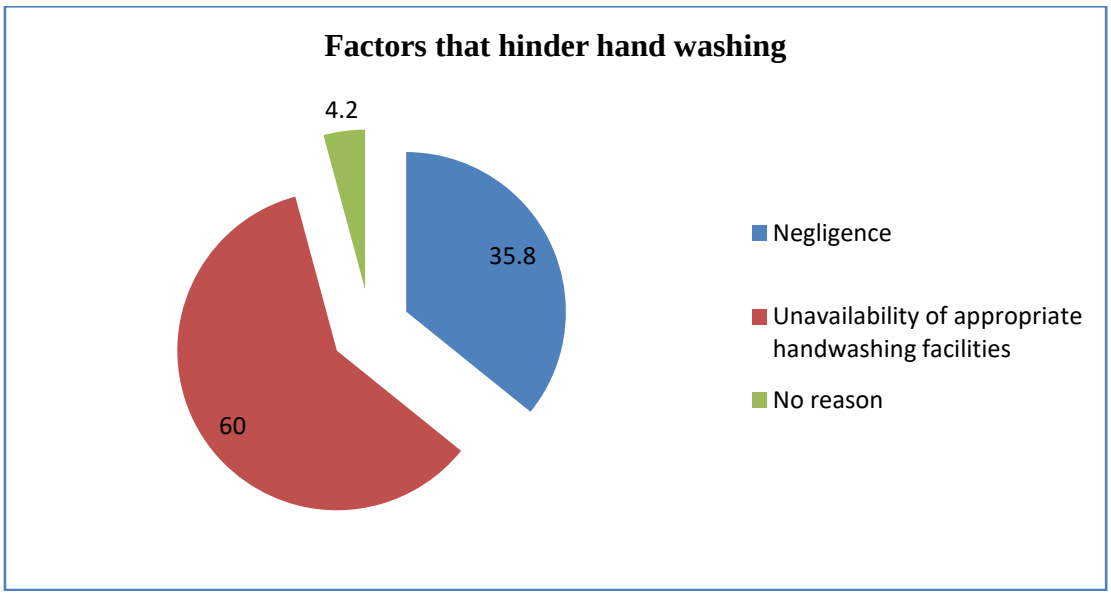

Fig. 4. Factors that hinder hand washing
Source: Field work, 2021

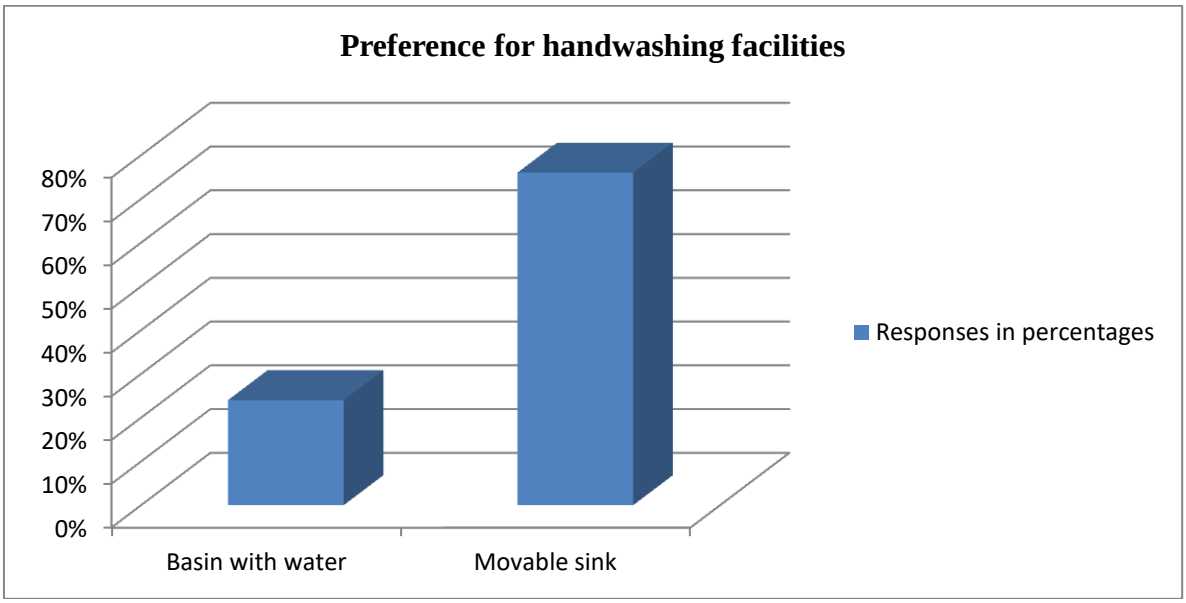

Fig. 5. Preference for bowl with water or a movable sink
Source: Fieldwork, 2021

3.1 Reasons for Choosing a Stable or a Movable Sink Basin

From the 32% who chose stable over moveable, approximately 8% indicated the movable sink would require more work to dispose of the water gathered after usage, thus they would continue with the stable, which disposes of the water promptly through a drain. 12 percent of participants chose the stable hand wash basin for no reason, while 5.7 percent did so for economic reasons.58 percent of the 68 percent of participants who chose the mobile hand wash basin did so for specific reasons. The creation of moveable hand wash basin will aid and increase or promote hand washing while also making it more convenient.

3.2 Working Procedure

Tools and Materials: Fiberglass, clay, plastic of paris, hardener, polyester resin, silicon sealant, brush, sandpaper, hammer, chisel, nails, wheels, tap, and grinder.

3.3 Preliminary Sketches

For preliminary sketches, different steps have been followed.

3.4 Step One

Poured about 2 litres of polyester resin, mixed with about 0.001mlof accelerator, and stir thoroughly. After the mixture was ready, we poured about 100 ml of it into another container (it could be a bottle cut into two). Add about 0.5 ml of hardener to it and stirred vigorously. The image below illustrates the mixture.

3.5 Step Two

The researchers modelled the sink to the required size and shape and left it in a cool place for 24 hours. Fig. 3 right depicts a modelled clay sink with a height of 15.1/8 and 18.1/8 width. Fig. 4 is also the application of the silicon on the model and also the clay walls with the clay slip partitioning at the centre of the sink for easy removal. We left it for 24 hours to dry.

3.6 Step Three

Apply silicon around the model (the number of hours the silicon will take to dry depends on its thickness around the model, also the thickness of the silicon depends on the amount of pressure you put on it when sticking it around the model). Because of the hot nature of the chemicals present in the silicon, prepare and apply a detergent solution that helps in sticking the silicon on the model which prevented the hands from peeling off.

3.7 Step Four

For easy removal, design a clay wall with a clay slip to partition the mould. With 2 inches sable

brush, gently apply the V to the silicon mould. After 30 seconds, we laid our strips of fiberglass on the silicon mould and dub the resin mixture.

3.8 Step Five

After mixing a little bit of resin and accelerator, add a measured amount of plaster of paris and a little bit of the hardener, stir until it is uniformly mixed, and apply it in the mould with the help of the brush. After drying it for some time, take the mould off with the help of chisel and a hammer.

3.9 Step Six

After drying it for some time, take the mould of with the help of the chisel and a hammer. Measure and cut the plywood to the required size and shape. Join the parts together and fix the wheels with the help of nails and hammer. After that, cutting of the angle iron from one side to the other side of the cage. The next is to measure the angle iron for the down part.

3.10 Step Seven

After cutting it was joined using the welding machine. After welding, it was grinded. Forming the cage through the following means: Cut 2 inches flat bar. Weld the flat bar to the angle iron. After welding, the parts were grinded together. After grinding, it was sprayed with red oxide to prevent rusting. After spraying, red oxide and filler were applied.

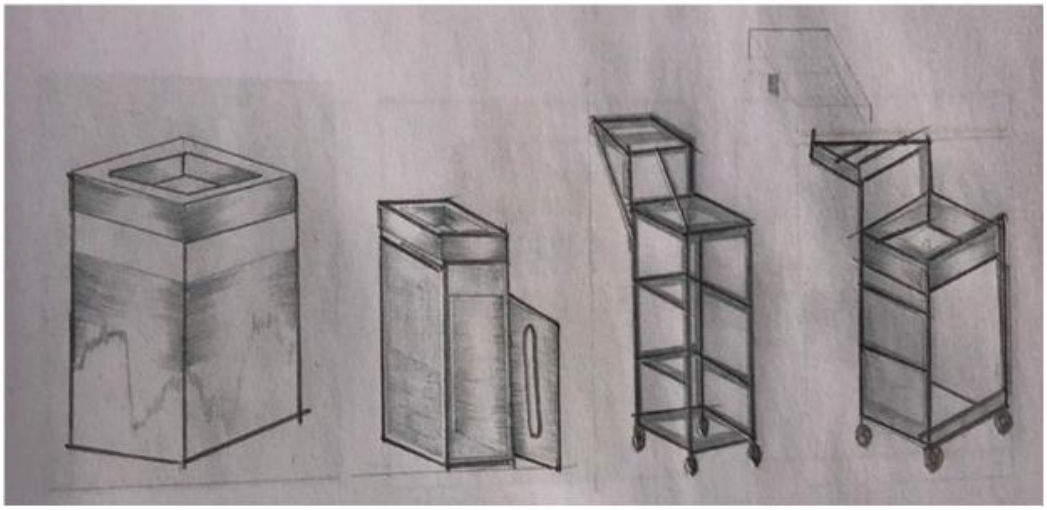

Fig. 6. Stages of idea development
Source: Field work, 2021

Fig. 7. A mixture of polyester resin and accelerator
Source: Fieldwork, 2021

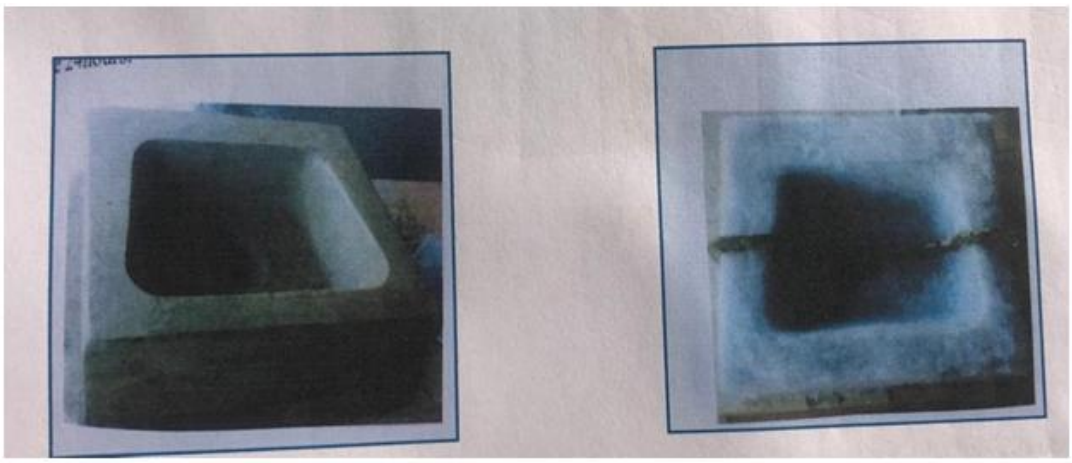

Fig. 8. A modelled clay sink
Source: Fieldwork, 2021

Fig. 9. A modelled clay sink without the mould
Source: Field work, 2021

Fig. 10. Measuring of the iron bar
Source: Field work, 2021

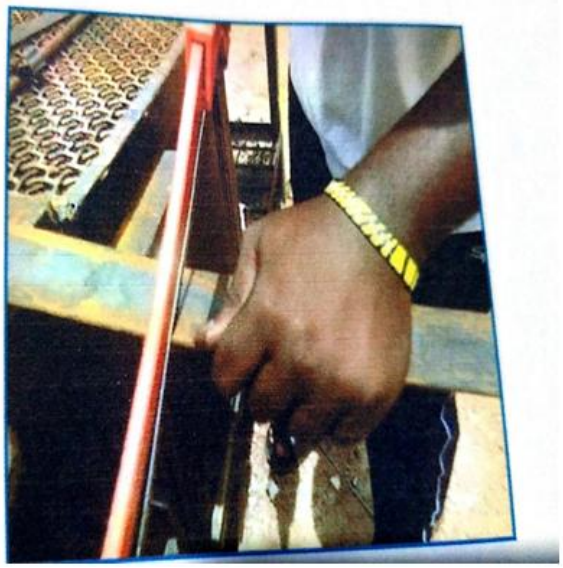

Fig. 11. Cutting of the flat iron bar
Source: Field work, 2021

Fig. 12. Welding of the flat iron bar
Source: Field work, 2021

Fig. 13. The base of the cage formed
Source: Field work, 2021

Fig. 14. The finished fiberglass mobile sink basin
Source: Field work, 2021

4. CONCLUSION

Throughout the investigation, the researchers discovered that negligence (35.8%), lack of handwashing facilities (60%) and no reason for not engaging in handwashing accounted for 4.2%. Based on the results from the fieldwork, the researchers developed a mobile hand washing basin that would facilitate and encourage the practice of hand washing. Handwashing has been established as an easy means of achieving adequate hand hygiene. Because handwashing with soap has numerous cross-cutting benefits, it is critical to incorporate handwashing promotion activities into interventions such as nutrition, early childhood development, health, and inclusion initiatives. Prioritizing handwashing within these activities will have a higher impact. Handwashing habit formation is transforming handwashing from a behaviour that people choose to engage in (intention) into an action that is an automatic response that does not involve the decision-making portions of the brain (habit). Handwashing would thus become a part of our everyday practice. In the face of the global COVID-19 pandemic, the data suggested that the development of a mobile sink basin would encourage people to practice hand washing due to its convenience, accessibility, and portability. It is also recommended that the Ministry of Health in Ghana must seek for funding avenues and liaise with Art institutions in organizing competitions amongst students and staff for innovative projects in Art specifically targeted at arresting the daunting health-related issues such as hand washing to curb the spread of infectious diseases.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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