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Use of campus plastic pet (Polyethylene terephthalate) bottles in the construction of a mini student relaxation hub at the college of education, Ilorin: A waste-to-wealth reusing approach

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ABSTRACT

The methodology used in the study is Re-using approach among the three "Rs" of waste management, the study specifically aims to construct a prototype building that will serve as a students' relaxation hub using the campus waste "Polyethylene Terephthalate" (PET) littering around, as well as to evaluate the durability of the relaxation hub constructed with waste plastics for future recommendations on plastic reusing as a means of managing waste globally. Plastics are a rapidly growing segment of municipal solid waste (MSW). Plastics were significant constituents of MSW categories in our environments. The human population is increasing, and the consistent demand for plastic products is responsible for the continuous increase in the production of plastics; hence, the generation of plastic waste is higher. Therefore, plastic waste forms a larger percentage of the sources of environmental pollution in Nigeria. The hazardous chemical constituents of the plastic (PET) and its effects on environmental and public health are a major concern to public health practitioners and environmentalists. Finding shows that improper disposal of waste plastics and open-air burning do lead to the release of very harmful chemicals into the environment, thereby causing public health hazards. It is imperative for every civilized society to find a lasting solution to these problems. It was concluded from this that plastic bottles can be used as building blocks for small-scale economical construction; hence, this practically implies that, the secondary function of waste plastic bottles.

Contribution/Originality: This study documents an alternative method of managing plastic waste to incineration, which has been causing air pollution and posing significant health risks. Furthermore, a secondary function of waste plastic was discovered through this research, i.e., waste plastic PET serving as building blocks in the construction of a bulletproof building.

1. INTRODUCTION

Plastics, such as PET, are made up of synthetic organic polymers, which are widely used in different applications ranging from water bottles, clothing, food packaging, medical supplies, electronic goods, and construction materials [1]. As of 2008, the annual plastic production was estimated to be 245 million tons globally [2].

There are different types of plastics based on their constituents and the type of materials used in their production. Polyethylene terephthalate (PET) is a type of plastic that is smooth, transparent, and relatively thin. It is also called stomach plastic due to the fact that people feed on the contents inside. Because PET is anti-inflammatory and fully liquid, it is commonly used in disposable salad dressing, juice, drinks, cooking vegetable oil, cosmetics, soft drinks, margarine, and water bottle production; thus, it is correct to conclude that they formed the

majority of waste generation on our campuses because the student population will always be a determining factor to its consumption both on campus and while in the hostels.

Worldwide, the most common plastic is polyethylene. High-density polyethylene is a heat-resistant plastic produced from petroleum. It is a major constituent of milk containers, soft drinks, varieties of plastic bags, etc. High-density polyethylene containers are generally considered safe for drinks and food because they have no reported health risks, even though some studies showed that long-term exposure of the plastics to sunlight can make them harmful for consumption.

Low-density polyethylene is heat-resistant, fragile, flexible, and rigid. It is commonly used in the packaging of milk, frozen foods, and juices. Because the plastic does not have any component that is harmful to the human body, its usage is termed safe for beverages and food. Plastics made from PET must be protected from high temperatures so as to prevent the leaching of some toxic additives such as acetaldehyde, antimony, and phthalates. Polycarbonates are used for packaging consumer goods such as reusable bottles.

The major issues in plastic waste centered on microplastics due to increased difficulty in monitoring and a greater impact on environmental and public health at the physical and chemical levels due to their higher volume-to-surface area ratio [3]. Inadequate waste management and indiscriminate dumping are the major routes of entry of microplastics into the marine environment, which is a current concern to see if the source can be reduced, if not eradicated.

The reuse of plastic bottles is a more efficient solution than recycling. These reuses are applied here to building projects, which will soon gain popularity in Nigeria due to the fact that building with plastic bottles is low-cost and eco-friendly.

In this study, waste plastic bottles were successfully used as building blocks (See Appendix I). Therefore, plastic bottles can be treated as a building block material similar to bricks for small-scale construction. As a result, a secondary function of waste plastic bottles will be to keep them from being thrown into landfills or incinerated which releases extremely toxic gases and eventually leads to environmental pollution and respiratory health hazards.

When used instead of building blocks, waste PET bottles are an inexpensive building material. The benefits of using these waste PET plastics include that the total waste generated is reduced, the source of building material is local, making it readily available, and there is no additional cost for the same. The natural resources are preserved, the carbon footprint is reduced, the plastic bottle is inexpensive, and the technology used is small and should be easy to implement.

2. OBJECTIVES OF THE STUDY

The main objectives of the research are to construct an experimental student relaxation hub using waste PET plastic found around the campus as a means of managing waste plastics as opposed to recycling and to evaluate the durability of the student relaxation hub with the materials used.

2.1. Statement of Problems

Packaging and plastic bottles are unlimited today. They comprise a large portion of the waste that forms greenhouse gases all around the world.

Plastics became an indispensable and versatile product with a wide range of properties, chemical compositions, and applications. Although plastic was initially assumed to be harmless and inert, many years of its disposal into the environment have led to diverse associated problems.

Environmental pollution by plastic wastes is now widely recognized to be a major environmental burden, especially in the aquatic environment where there is prolonged biophysical breakdown of plastics with detrimental negative effects on wild life. This has become a serious global environmental and public health concern due to its

large production volume and the presence of inadequate management policies in several countries, including Nigeria.

The cost of manufacturing cement was said to be on the rise, which invariably affected the unit cost of cement. Since bricks (blocks) are made with cement as a major ingredient, this automatically affects the cost of bricks. Reusing waste PET plastic will be a major landslide in reducing the demands for cement bricks and the financial budget when constructing a building. Colas and sodas are the most popular soft drinks among students and faculty at Kwara State College of Education in Ilorin. These range from PET bottles of cold water to drinks such as Pepsi, Coca-Cola, Fanta, and energy drinks. The volumes and the rate at which these soft drinks were consumed and disposed of indiscriminately on the campus are alarming and call for solutions.

Despite the college administration's efforts to provide waste disposal facilities at various strategic points on campus for easy and accessible waste disposal, there is growing concern about the rate at which the college environment is polluted by plastic PET. A lasting solution such as reusing the waste plastics for another useful and creative purpose on campus might be a better solution. Because of the large number of students enrolling in higher education institutions, adequate funding and basic infrastructure, including student housing, are required. Mini relaxation hub, which is also lacking on our campuses; hence, it is timely if waste plastic PET bottles can be used to construct students' mini relaxation hub.

3. LITERATURE REVIEW

The study discovers theory on Golden Plains Shire Council [4] proposed waste management theory called "THE 7 R'S OF RECYCLING," which is recycle, refuse, reduce, reuse, repair, refill, and recover. Although the researcher here is focusing directly on the fourth "R," which is to "reuse," Reuse is explained according to the 7 R's as a means to find new ways to use things that otherwise would have been thrown out.

Globally, plastic production was estimated to be 380 million metric tons in 2018. Plastics weighing approximately 6.3 billion metric tons were produced worldwide between 1950 and 2018.Humans have created 8.3 billion metric tons of plastic since large-scale production of the synthetic materials began in the early 1950s, and most of it now resides in landfills or the natural environment [5].

Researchers found that by 2015 [5], humans had generated 8.3 billion metric tons of plastic, of which 6.3 billion tons had already become waste. Of that waste total, only 9 percent was recycled, 12 percent was incinerated, and 79 percent accumulated in landfills or the natural environment.

If current trends continue, roughly 12 billion metric tons of plastic waste will be in landfills or the natural environment by 2050. Twelve billion metric tons is about 35,000 times as heavy as the Empire State Building [5]. Most plastics don't biodegrade in any meaningful sense, so the plastic waste humans have generated could be with us for hundreds or even thousands of years. Global production of plastics increased from 2 million metric tons in 1950 to over 400 million metric tons in 2015, according to the study, outgrowing most other human-made materials. Notable exceptions are materials that are extensively used in the construction sector, such as steel and cement [5].

Globally, plastic production was estimated to be 380 million metric tons in 2018. Since 1950 to 2018, plastics of about 6.3 billion tones have been produced worldwide, 9% and 12% of which have been recycled and incinerated, respectively [2]. Plastics weighing approximately 5 million metric tons are consumed each year in the United Kingdom alone, with only about one-quarter recycled and the remainder landfilled. It has been suggested by researchers that by 2050, oceans might contain more plastic than fish in terms of weight [6]. Yearly, approximately 500 billion plastic bags are used, of which an estimated 13 million tons end up in the ocean, killing approximately 100,000 marine animals [6].

The reprocessing of recovered plastic scraps or wastes into usable products is called plastic recycling. Most plastics are non-biodegradable by nature; hence, the fundamental work is reduction of waste emissions, effective

management, and recycling of resulting wastes [7]. Recycling of plastics is a major aspect of the worldwide efforts to minimize the 8 million tons of plastic waste entering the Earth's oceans each year [8, 9]. According to Hopewell et al., plastic recycling terminology is complex due to the variety of recovery activities and recycling. There are four main categories of recycling, which are: primary (which involves the mechanical reprocessing of plastics into a new product with equivalent properties); secondary (which involves the mechanical reprocessing of plastics into a product with lower properties); tertiary (which involves the recovery of the chemical constituents of the plastics); and quaternary (which involves energy recovery from the plastics).

4. MATERIALS AND METHODS

4.1. Description of Study Area or Site

The study was conducted at the Kwara State College of Education, Ilorin. The school is in the heart of the Ilorin metropolitan area, specifically near the popular sawmill area, Geri Alimi axis, Umar Saro Road, and Ilorin, Kwara state.

The main site of the study is inside the college of education on the Ilorin campus, specifically around the school of sciences. The main subjects and materials that were used in this study were empty plastic PET bottles, waste sawdust, and cement.

4.2. Methods

The procedures followed were broken down into the following activities:

The site where the relaxation hub was constructed was carefully selected with the permission of college management through the director of works. The research school (the school of sciences) was given preference, and the sitting was also closed to a natural shield (trees).

The researcher in conjunction with some selected student formed a team called; Team COED Recyclers 2021." The team comprises 20 male students and 20 female students, for a total of 40 students. This newly formed team was in charge of collecting all empty plastic PET bottles that littered the campus. They accomplish this by periodically visiting all refuse dump sites on campus, sorting and collecting waste plastic bottles and the like from dustbins strategically placed around campus, and periodically visiting the river/water erosion site on campus to pick up sediment of plastic PET bottles.

At the end of six (6) months, a total of 10,000 waste empty plastic PET bottles were collected.

In order to achieve a pattern of arrangement so as to enhance the aesthetic look of the relaxation hub, it is important to sort the waste PET into different categories.

It is important to remove the nylon brand wrapped around the empty waste plastic PET bottles collected before use so as to prevent the nylon from not allowing the plastic to glue together when adhesive materials are added.

Sawdust is one of the essential materials needed for this project. The sawdust was mixed with a little sand and water. This mixture was left for 24 hours to allow fermentation to take place. The product formed after fermentation can be used as an adhesive to gum the bottles together as an alternative to pure cement. Although to increase the bond between the particles, pure cement was added to the mixture of sawdust, red soil, and water for the molding process so as to improve the quality of the building and to withstand disturbance from the students, since the majority might be careless in the way they interact in the relationship center.

This soil was mixed together with the sawdust in a ratio of 40% (red soil) to 40%(sawdust) per 20 kg of sawdust, while pure cement formulated the remaining 10%. Proportional water was used to mix the materials together. Caution was taken so that the mixture wouldn't be watery, since what was needed to be achieved was a semisolid mixture.

Meanwhile, pure cement, soil, and small stones were used to lay the foundation in order to make the bedrock stronger and more resistant to carrying loads. All these materials described above were used to construct the building (see Appendix 1).

5. RESULTS AND DISCUSSION

Waste to wealth: a carefully curated collection of waste plastics (PET) is used to construct a mini relaxation hub inside the Kwara State College of Education, Ilorin, Nigeria. The addition of sandy soil filled inside the waste plastic PET makes it bulletproof and therefore could be used to construct a community security post as recommended below. This discovery of filling the waste plastic PET with sandy soil makes the research worthwhile and apt, since Nigeria, among other nations, is currently facing serious security challenges. Security agencies have tested and confirmed it, as seen at major military checkpoints along Nigerian roads where sandbags were parked inside empty sacs to form barricades and also served as bulletproof as applicable to the aforementioned discovery. This has expanded the secondary functions of waste plastic PET, which can also be used to construct security posts and community vigilante security posts, among others.

The aesthetic scene that the construction from waste plastic PET created added to the beauty of the campus when it was completed. The construction of the mini-relaxation students' hub created a beautiful scene in the area inside the campus where the building was located; students were occasionally seen taking group and personal pictures using the waste plastic PET building background because it is not a regular building student see in their various communities.

The first stage in the rendition of waste materials is the collection of waste plastic PET junk, followed by the collection of empty plastic PET bottles, the sorting of the collected empty waste plastic PET bottles into different sizes, textures, colors, and shapes, and the removal of the cellophane nylon from the collected empty waste plastic PET bottles [10]. The remaining stages include the collection of sawdust and sand, the mixing stage, making foundations, building, and constructing.

5.1. Statistics Analysis of the Building

The Table 1 Shows the statistical properties of the materials used in the construction of the plastic house. It shows in exact ration of each materials and dimension of the building. Majorly the table presents the value of total numbers of empty plastic bottles reuse, the ration of soil to sawdust, the ration of sawdust and soil to water and Percentages of the different categories of empty plastic used.

Table 1. Statistical properties of the plastic building constructed (Mini students relaxation hub).

Items	Statistics
• Total numbers of empty plastic bottles reuse	10.000
• The ration of soil to sawdust	40%
• The ration of sawdust and soil to water	40%
• Percentages of the different categories of empty plastic used	20%
• Land mass covered	20 ft by 18ft
• Size of the mini relaxation hub (Dimension)	15ft by 12ft
• Total number of possible students it can house	10 Students at a time
• Height of the relaxation hub constructed	12ft

Stage One: Collection of waste plastic PET

Stage Two: Sorting of collected empty waste plastic PET bottles in to different sizes texture, colors and shapes

Stage Three: Removing of cellophane nylon on the collected empty waste plastic PET bottles

Stage Four: filling Empty Plastic PET bottle with sandy Soil (Serving as bullet proof purpose)

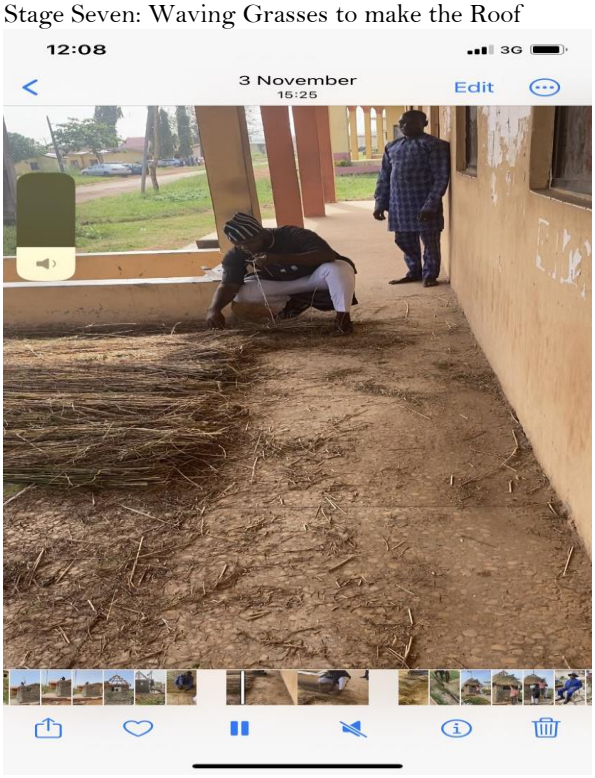
Stage Five: Making Foundations

Stage Seven: Building and Constructing

Stage Six: Making Roof framework

Stage Seven: Waving Grasses to make the Roof

Stage Eight: underlying the grass roof with nylon to prevent water from entering during raining season



Stage Nine: Landscaping

Stage Ten: interior designing

Complete Structure

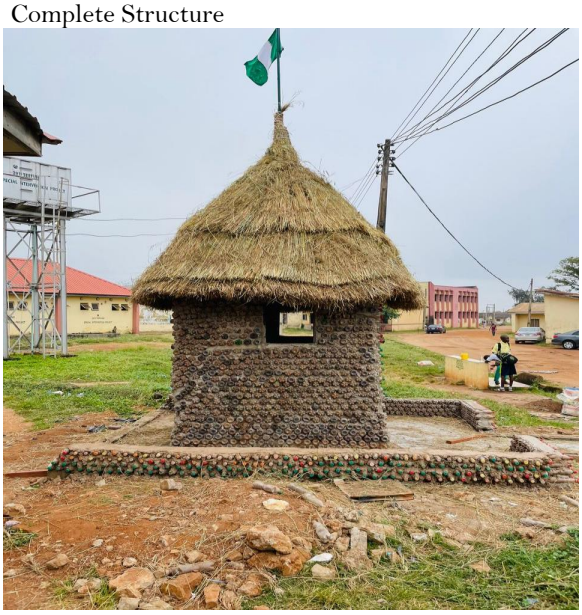


Figure 1. Stages and steps involve in constructing mini students relaxation hub using waste plastic bottles.

Figure 1 illustrated all the detail step by step procedures and stages involved in constructing the waste plastic building (Mini Students Relaxation Hub).

5.2. Conclusion

Environmental waste management can be achieved through diverse processes by different platforms, including individuals, corporate organizations, researchers, non-governmental organizations, the government, and community efforts. From this study, it is imperative for us as the custodians of our immediate environment to look into the secondary uses of the waste we generate from our domestic consumption rather than recycle, as it is

commonly practiced in most parts of Africa, Nigeria included. The author believes that recycling waste materials is targeted to produce the same materials in their second life. There should be a significant shift away from recycling as the first option among the three "Rs" of waste management, which are recycling, reusing, and reducing the status quo. Reusing waste plastic PET will be a more eco-friendly and cheaper form of waste plastic PET management, since its reuse will give it a second chance to live, but this time it will be permanently put to rest. This could be archived by using waste PET to construct a student mini relaxation hub, a recreational garden, a flower garden, a security duty post, an animal cage, and a pet house, among others. This is one aspect of converting waste to wealth and creating a safe and sustainable environment.

5.3. Recommendations

The management of Kwara State College of Education, Ilorin, the Kwara state government, the federal government of Nigeria, and the governments of other countries around the world where tons of waste plastic PET bottles are generated in large quantities due to high consumption of drinks and beverages should embrace, encourage, appreciate, patronize, and include the reusing of waste plastic PET bottles as an alternative to building blocks when constructing recreational outfits, among other uses outlined in this research.

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APPENDIX

Side view

Front view

Appendix 1. Structure of the student's mini relaxation center prototype constructed from waste plastic PET bottles.