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ARTPRENEURSHIP IN WASTE REPURPOSING: AN EXPERIMENT WITH PLASTIC WASTES FOR PAVING STONES

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Introduction

Interlocking stones (blocks) are paving stones made from concrete aggregates like granites, stone dust with water and cement (which serves as bond agent). There are specialized plastic mould designs for producing the blocks, which are arranged repeatedly and rhythmically such that the shapes interlock without the aid of mortar during the arrangement on the floor (Adenle, 2007). These paving stones are found everywhere today especially in public places, and highbrow residential areas. People have gone a step further to experiment using locally sourced materials like gravel with soft sand to replace the quarried granite and dust. Exploring the potentials of our waste streams to recycle as substitute entirely for granite and stone dust using plastic waste is the concern of this experiment. Giving redirection to what is otherwise called waste takes creative and innovative efforts of a stable mind.

Kasturi (2012) observes that, "artpreneurship" or art and entrepreneurship "allows us to see something new in the existing material, or creatively adapting existing works". Waste plastics of all sorts pose a great challenge to the socio-economic and health life in Nigeria. Many attempts have been made to reduce the waste stream through recycling for the purpose of domestic usage. Despite this, the products of such still find their way back into waste streams, hence the need for this study that gives innovative redirection to plastic wastes for making paving stones. This study therefore dwells on the choice and tendering of industrial plastic wastes that otherwise serve as environmental pollution and hazard, to repurpose and reuse them in uncommon ways.

Literature Review

Erwin and Haley (1990) state that, "society's expectations related to environmental protection continue to rise. Methods used even a decade ago for disposing of waste are unacceptable today". This gives further impetus to recycling as a means of getting rid of waste since it is accepted to be more environmentally friendly than other methods of waste disposal. Once plastic materials enter the waste stream, they pose great treat to humans, animals and the environment hence recycling is seen as the next option. Maryruth (2011) lends credence to this by identifying areas of hazard from the pre-production of plastic chemical, the manufacturing, consuming to its being discarded. He notes that Plastic materials are "non-renewable, toxic, ending up in the ocean and non-degradable. Some plastics are non-renewable because they are made from crude oil. We have only a limited supply of the resources we need to make plastics.

They are toxic because creating plastics from crude oil requires the use of toxic chemicals that are then washed into our waterways, our soil, and emitted into the air thus causing toxic pollution to land sea and air. Also much of our plastic ends up in the ocean where it is gathered into what is now known as the plastic island in the Pacific. The plastics are also non-degradable because most of them take more than a hundred years to do so. That means resources are locked up in landfills for

centuries, unusable and wasted. If these plastic wastes that are ending up in waste garbage and landfills are properly channelled and recycled however, much resources will be conserved. Sharma (1995) observes that "recycling is increasingly being regarded as the preferable option of disposing waste for the promise it brings of saving resources and energy and reducing pollution".

Recycling is clearly a waste-management strategy, but it can also be seen as one current example of implementing the concept of industrial ecology, whereas in a natural ecosystem there are no wastes but only products (Frosch and Gallopoulos, 1989; McDonough and Braungart, 2002). Industrial ecology and natural ecosystems share the same idea with Conceptual Art that sees products from wastes or worthless things and also has zero tolerance for wastes. Jefferson, Robert, and Edward (2009) and Godwin (2011) reiterate that recycling of plastics is one method for reducing environmental impact and resource depletion. He submits that, "Fundamentally, high levels of recycling, as with reduction in use, reuse and repair or re-manufacturing can allow for a given level of product service with lower material inputs than would otherwise be required."

This infers that reuse or reabsorbing of waste materials that would have otherwise constituted environmental hazards, into permanent aesthetic, utilitarian or environmental work by artists especially sculptors, seeks to work in tandem with the goal of becoming more environmentally friendly to conserve natural resources and protect the environment, which is "Going Green". Engaging waste this way, one would have succeeded in cutting short the usual chain of recycling.

Jefferson et al (2009) further observe that recycling of packaging materials has seen rapid expansion over the last decades in a number of countries; they note that the quantities that are recycled vary geographically according to plastic type and application. Though many of the factors associated with recycling are of social or environmental factors, however for most artists and creative individuals, the motivation to recycle and reduce the plastic wastes come from our desire to protect the environment. This is revealed in the words of Nelson Boateng who said "Working towards a cleaner environment is my heart" (Kwasi and Commentary 2018). Boateng, an entrepreneur from Ghana, produces paving blocks using all kinds of plastics except PVC pipes. The plastic waste material is first shredded to a particular size using a shredding machine, melted and mixed in ratio with sand and red oxide.

Plate I, Laying the recycled plastic-infused blocks. Source: NELPLAT

The 21st century has witnessed a lot of creative ingenuities from pro-active entrepreneurs who keep on researching into how best going green can be achieved. Recent studies in this direction have shown some hope in terms of using plastic-waste in road construction. According to Aparna (2016), "the technology for this was developed by the 'Plastic Man' of India, Prof Rajagopalan Vasudevan, Professor of Chemistry at Thiagarajar College of Engineering, Madurai. Vidhisha (2014) corroborating this point, states that the first road using waste plastics was laid in Kovilpatti village of Tuticorin district in October 2002.

Plate 2, A road made of waste plastic in India, Photo Source: walkabilityasis.org

The methods used in plates 1 and 2 slightly differ, even though both used melted plastics. In Plate 1-sand and red oxide were additional components in which heated plastics served as the bond whereas in Plate 2 heated plastic is mixed with bitumen to achieve the tar. This study provides a different approach to achieve the result. All plastic types (thermoplastics and thermosetting) are worked into the experiment in this study. This is because the study did not undergo heating or melting of plastic but made use of cement as bond agent.

Conceptual Review

Waste has been defined as something that is not or no longer useful and is to be thrown away or disposed of. In the words of Ogwueleka, (2009) "wastes are materials that are not prime products (that is products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose." Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. From the standpoint of this work, wastes are materials lacking direct value to the producers or consumers and so must be disposed of. If wastes are managed properly however, they could turn the tide of a downtrodden economic.

It is common sight in Nigeria today to see heaps / accumulation of festering waste dumps in our urban and commercial cities. All sides of residential apartments, the drains, the highways, corners of major and minor streets, undeveloped plots of land have all become waste dumps for many households. As Peter (2011) puts it, "waste increases in a geometrical progression and collection and disposal is at an arithmetical progression." This infers that generating wastes is an easy and unstoppable phenomenon while disposing the wastes is a challenge. Waste, explains Bashorun is seen not only in the volume of disused materials littering the Nigerian landscape but also as a

symbol of "...our indifference to our wasteful lifestyles...we are a nation that wastes everything; human lives, time, minds, words, energy, natural resources, food, money, population, land, knowledge, culture, tradition, spirituality and more" (Bashorun in Onipede 2018).

Plastic material is any of a wide range of synthetic or semi-synthetic organic solids used in the manufacture of industrial products; it falls among non-degradable categories of wastes resulting from production mistakes in the factory, wastes due to disuse or expiration of products and domestic wastes. Arueyingho and Adenle (2012) affirm that, "plastics are typically polymers of high molecular mass, and may contain other substances to improve performance and or reduce production costs". Plastic materials that allow objects to be cast, pressed, or extruded into a variety of shapes – such as films, fibres, plates, tubes, bottles, boxes and much more are of two types and are called "Thermoplastics and Thermosetting polymers" (Arueyingho 2011).

Arueyingho also notes that thermoplastics do not undergo chemical change in their composition when heated therefore, they can be used and be reused. This is the type commonly scavenged (from dust bins, water ways or streets and landfills), sorted and recycled by industries for domestic uses. Thermosetting on the other hand can only be melted and shaped once, hence its permanence, inconvertible almost non-recycled state. The thrust of this study is hinged on the flexibility provided by the reuse of Thermoplastics and Thermosetting wastes to produce interlocking paving stones.

Theoretical Framework

This study adopts the Theory of Waste Management to expound its objectives. The Waste Management Theory is hinged on the considerations that waste management is to prevent waste causing harm to human health and the environment, and application of waste management leads to conservation of resources (Pongrácz, Phillips and Keiski, 2004). The study fits into class 1, 2 and 3 of the classes of wastes in Table 1 below as propounded by Pongrácz and Pohjola (1997).

Table 1: Classes of waste

Class 1	Non-wanted things, created not intended, or not avoided, with no purpose.
Class 2	Things that were given a finite purpose, thus destined to become useless after fulfilling it.
Class 3	Things with well-defined purpose, but their performance ceased being acceptable due to a flaw in their Structure or State.
Class 4	Things with well-defined purpose, and acceptable performance, but their users failed to use them for their intended purpose.

Source: Pongrácz and Pohjola 1997.

Relating the table above to this study, Class 1 consists of unwanted plastics Pellets/chips and dusts spilling off the production line or deformed plastics. Classes 2 and 3 consist of household plastics such as creams, pomades, water bottles, packaging, domestic buckets, bins, storage plastics, plastic bottles, pots, tubs and trays, plastic film, rigid plastics, crates, pipes, mouldings, plastic foams, such as expanded polystyrene (EPS), flexible plastics, such as strapping and cable sheathing.

The waste plastics would undergo crushing or worked on with machine to produce varying grades (sizes) such as dusts, shaven and ½ inch. These formed the 3 aggregates used in this study, which agrees with one of the Principles of Industrial Ecology. It states that, "Every product should be designed so that it can be used to create other useful products at the end of its life" (Pongrácz, 1997).

Method
The method used was the usual method of casting concrete. Three experiments were made using 3 different aggregates and specified ratios. The ratio of each aggregate was mixed thoroughly with cement and water to achieve mortar; this was poured into moulds already primed with oil and little cement slip. It was allowed to set and removed after twenty four hours.

Materials Substitutes for the Experiment
The materials used for this experimental research are:

- Cement
- Plastic dust
- Shredded Plastic or shaven
- Plastic pellet
- Water
- Plastic mould – mould used for making conventional paving bricks

Plastic dust, shaven and pellet are used in this experiment substitute to granite, sharp sand and stone dust that are conventionally used for paving stones or interlocking blocks.

Plate 3, Plastic Dust (PD) (fine aggregate), Source: John Adenle

It is the Industrial Crumbs or waste that fall during production at the finishing stage, usually dusty, light and often times with small pellets.

Plate 4, Plastic Shaven (PS) (Shredded aggregate), Source: John Adenle

The shaven or shredded derived from cutting of lump of plastic with shredding machine.

Plate 5, Plastic Pellets (PP) (coarse aggregate), Source: John Adenle

Pellets are small grains from bigger lumps of plastic that enable easy melting, usually a little above the size of rice grain.

Composition of materials and outcome
The following ratio was adopted to arrive at the products shown in the table below.

Table 2

	Aggregate Ratio	Cement Ratio	Behaviour/Observations
A	PD 3	2	Easily mixed
B	PS 3	3	Does not mix easily manually when water is added, needs additional efforts.
C	PP 3	3	Does not mix easily manually when water is added, needs additional efforts.

Note: PD = Plastic Dust, PS= Plastic Shaven, PP= Plastic Pellets

Results

Plate 6, Plastic Dust (PD), Source: John Adenle

This is a mixture of cement and plastic dust.

Plate 7, Plastic Shaven (PS), Source: John Adenle

A mixture of cement and plastic shaven.

Plate 3, Plastic Pellets (PD), Source: John Adenle

A mixture of cement and plastic pellet

Conclusion and Recommendations

Generally, the outcome of the three experiments are successful, they have the same outlook, but vary in weight. Even though the cement ratio of A, B, C are equal, the weight of C is the heaviest followed by A and B respectively. The reasons for these are due to the weight of the aggregates, C (plastic pellet) is heavier than "A" (plastic dust) while "A" is heavier than "B" (plastic shaven).

In conclusion, plastic aggregates with cement are also suitable and can be used as substitute for traditional aggregates (granite, stone dust and sand) used for interlocking blocks. If this is encouraged, it will reduce the waste stream of plastics in our environment.

Considering the impact of plastic waste in the environment and its non-biodegradable nature, Government should encourage reusing of plastics through provision of supports and grants for industries, which recycle and reuse wastes in order to drastically reduce plastic pollution. Creative individuals like sculptors should engage in exploring this or other possibilities because using plastics in such way (for interlocking blocks) keeps them from ending up in the landfill. It is also suggested that the 3 products from the experiments would further be subjected to various stress tests in collaboration with relevant engineers.

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