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## Review article

## Plastic wastes: environmental hazard and instrument for wealth creation in Nigeria

O. Kehinde<sup>a,c</sup>, O.J. Ramonu<sup>c</sup>, K.O. Babaremu<sup>a,\*</sup>, L.D. Justin<sup>b</sup><sup>a</sup> Department of Mechanical Engineering, Covenant University, Ota, Ogun State, Nigeria<sup>b</sup> Department of Civil Engineering, Covenant University, Ota, Ogun State, Nigeria<sup>c</sup> Department of Mechanical Engineering, Federal Polytechnic, Ilaro, Ogun State, Nigeria

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## ABSTRACT

Combating the menace of plastic waste pollution has become a global environmental challenge. Plastic pollution is capable of affecting land, waterways and oceans as a large percentage of marine and land creatures have died due to the fact that plastic is non-biodegradable and it causes hazards to soil. It also emits toxic gasses when exposed or heated up. It blocks drainage lines and fill up land space causing floods and erosion thereby causing deterioration of the Nigerian roads. Plastics wastes are also harmful to human health; they may contain harmful acids which may lead to death. Nigeria, which is the biggest oil exporting country in Africa, relies mainly on the proceeds of the oil trade for its GDP and based strategy in growing her economy. However, with the declination of oil prices and increase in plastic wastes, the world is tending towards energy and sustainable development. Therefore, an urgent need for recycling plastic wastes into a solution for wealth creation is fundamental in Nigeria. This paper therefore seeks to identify favorable methods for recycling plastic wastes in Nigeria as a tool for solution to diversification and implementation. Evidence based examples are illustrated in the article with viable solution recommended for implementation.

## 1. Introduction

Waste management is one of Nigeria's greatest challenges. These wastes are in form of polymers and plastics which research has shown that they are difficult to manage. One major factor that leads to poor waste management in Nigeria is due to the higher population density [1]. Manufacturing plastics and plastic products has increased this year and higher than any other amount recorded in the world. Its production increased in just one year by 13million tons between the year 2015 and 2016 [2]. Fifty percent of the plastic products fall within the disposable products category since they are single-use plastic products and packaging materials. It is a common practice to see a large number of waste plastic products not collected in waste bins for further processing, recovery and standard disposal via recycling centres, incinerators or landfills, rather, they are carelessly scattered or discarded into regions that are inaccessible for waste collection and hence terminating the possibility of recovery/recycling. The usual practices include plastic bottles and containers being thrown on the ground, thrust out of vehicles, hipped around narrow passages or blown away by wind which litter the surroundings and subsequently pollute the immediate ecosystem. This

continuous piling up of plastic waste products is becoming a serious global environmental challenge and threat the ecosystem. Research shows that about 10 percent by weight of municipal solid waste content are plastics as plastic waste occupies about 90% of the three populous rivers in the world and is known to be responsible for the death of 20–30% of marine life. There are more than seven million tons of additional plastic waste deposits in the earth annually, and by this plastic growth trend, the sea would have more plastics than fishes and over more 97% of the of the bird would have consumed them [3]. Plastic wastes are hazardous not just to land animals but also to aquatic life as well and therefore a global challenge Therefore, plastic waste are environmental disasters already occupying the earth, thus a need for acute adoption of plastic management techniques [3].

Most plastic materials are commonly grouped under the term 'Polymers' to describe them as either organic or carbon-rich compounds having a long chain pattern of connected molecules. Plastics are mostly organic polymers of increased molecular mass [4]. The word plastic was coined from the Greek phrase *plastikos* that denotes the ability of materials to be shaped or moulded when there is change in temperature. This is why heat is used in most plastic manufacturing processes to

\* Corresponding author.

E-mail address: [kunle.babaremu@covenantuniversity.edu.ng](mailto:kunle.babaremu@covenantuniversity.edu.ng) (K.O. Babaremu).

produce plastics products. While thermoplastics are polymers that can be melted and reshaped, or recycled, a group of monomers or mixture of two or more monomers is used to produce to a family of polymers.

There exist a large number of polymers around us that are taken for granted and are so familiar of which some are generated from human activities. Natural polymers include products of glucose which are cellulose and starch, while rubber and proteins are derived from isoprene and amino acids respectively. Examples of polymers created by man's activities includes polyurethane, Teflon, Lucite, nylon, silicones, Dacron, Orlon, polyethylene, epoxy, polyester, boat resin and vinyl. Without doubt, polymers have had a huge impact on our culture and continue to do so. With the creation of these materials, challenges occurred with their application. Although most are not biodegradable, but they contribute a meaningful amount to the refuge created by man, plus their component raw materials still serve as a huge resource for man's need. Recycling of plastics is a relevant technique of waste reduction, energy and useful raw materials recovery process, for instance, Fleece clothing produced from recycled products has been available for purchase for many years [4]. Plastics can be categorized into four namely:

### 1.1. Natural plastics

They are natural substances which are classified as plastics due their property which permits them to be molten, molded and shaped easily when subjected to heat. For instance, amber is a fossil pine tree resin that is commonly used in the production of jewelry.

### 1.2. Semi synthetic plastics

These are plastics obtained from the combination of natural materials with other substances. For instance, cellulose acetate is the product of reacting cellulose fiber with acetic acid which is widely applied in cinema film production.

### 1.3. Synthetic plastics

These types of plastics are obtained when the molecular structure of carbon-based materials such as coal, crude oil or gas undergoes decomposition or 'cracking' process. This process which involves the subjection of such materials to pressure and heat forms the basic procedure used in petrochemical refineries for manufacturing most of the plastics commonly found around today. There are two other categories of synthetic and semi-synthetic plastics. These are classified based on the manner or way a standard plastic material will react after heating. These two categories are;

### 1.4. Thermoplastics

Any plastic materials whose property allows it to get soft and melt under heat and to be shaped or reshaped by taking the shape of a desired designed mold when cooled. The most distinguishing property of thermoplastics is that when reheated they can molten again. Styrene's and acrylics are the most common and perhaps the largest occurring examples of thermoplastics which were discovered in school workshops.

### 1.5. Thermosetting plastics

unlike thermoplastics, thermosetting plastics cannot be softened or molten when reheated, although at the first instance they will mellow and melt under high temperature. When molten they can be molded into shapes into which they were placed before cooling but afterwards they become permanent in the shapes into which they were set and any attempt to further subject them to heat will only make them brittle or burn. The commonest examples of these plastics include polyester resins which are used largely for glass reinforced plastics work and those mostly

employed in the manufacture of Formica for kitchen work surfaces such as melamine formaldehyde.

As stated in previous paragraph, plastics are synthetic or semi-synthetic materials which could molded into any object and still retain its plastic characteristic. Given their numerous good qualities such as low specific gravity, resistance to rust, ease of fabrication, low thermal and electrical conductivities, plastics have attracted wide interest in executing industrial and structural projects. In addition, most plastics possess variety of colours which is making them become a major resource for decorative functions [5]. In Nigeria today, there are more than a hundred plastic producing factories generating a-tons of plastic products which are commonly used by people due to the fact that they are easy to use, relatively cheap and very convenient [6]. Plastic are also used in making polytene bags which are used in carrying groceries or packaging food items. Plastic bottles are also products of plastic wastes. They are mainly used in packaging liquids and very a common waste in the streets of Nigeria; however, these forms of plastic are known as Polyethylene terephthalate commonly abbreviated PET or PETE. An estimate of over a billion plastic (poly) bags and PET bottles are used yearly in Nigeria, the local markets, food sellers, grocery stores, traffic food hawkers etc. however, without the sun's ability to melt this plastic materials and a proper disposal system, these plastic lay wastes on the soil, carried by wind to drainage or simple just fill up land space thus making them a hazard to the environment.

The rapidly developing economy of Nigeria boasts as the highest crude oil exporting country in Africa. This was followed the country's strategy to maximize the production and export of petroleum to drive its growth. However, given the country's unstable economic growth rate and the constant fluctuating world crude oil prices, Nigeria has not been able to maximize the huge opportunity to break out of the underdevelopment status despite the availability of large amount of human and natural resources at its disposal. For the years it has relied solely on its huge crude oil resources as the major source of revenue, while practicing a monolithic economy despite facing numerous developmental challenges. The most unfortunately part of this is the fact that the country have not even been able to manage the major resource [7]. Howbeit, with the world tending towards sustainability and the county's plastic wastes increase, it is essential Nigeria finds an alternative to improving its economy thus, a need to see plastic wastes as a solution to wealth.

Certainly, there is no gainsaying that plastics are becoming a major available resource in our environment. Although, problems are inevitable when they are poorly used or handled. In the process of plastic production and use major disposal problems arise which leads to poor aesthetics, fire hazards, health hazards, and energy shortages. Plastic waste recycling is definitely the most efficient approach to managing municipal waste, plus this can be perceived as a recent illustration for actualizing the model of industrial conservationism [8]. However, there are no wastes within a natural environment there are only products. Moreover, plastic waste recycling is an approach where its negative effects on nature and the prevention of asset exhaustion can be decreased and harnessed as a means to wealth creation.

## 2. Plastic waste as an environmental hazard

More plastic has been produced in the last years than was produced in the previous years. Globally, plastics demand rose from over 320 million tons in 2015 to more than 330 million tons in 2016 alone [2]. This implies that plastic waste is rapidly increasing its damage on all ecological systems and life [9]. Invariably, plastics have affected man's daily living and its continued usage and production especially in most low-income nations is now worrisome, since they may not be able meet up with the advanced techniques of plastic waste management [10]. Moreover, the qualities of plastics such as light weight and durability that make them so unique have in turn becomes a disposal problem. For instance, when used plastic products are trashed into the environment, they endure for long time in the surrounding due to the fact that they are durable, while those

thrown into water bodies continue to float on the surface because they are of low density [11]. Thus, the damage these wastes are getting to life and the ecosystem is increasing thereby causing severe environmental hazards such as water pollution, soil pollution and air pollution.

### 2.1. Impact of plastic waste on aquatic life

The life of earth's living creatures is largely sustained by water bodies such as rivers, streams, oceans etc., as they provide most of the oxygen it breathes. But the overwhelming negative effect of plastic waste is creating concerns over the condition of life and especially aquatic animals. It is estimated that not less than a million plastic bottles are tossed every minute, around 10 million units every minute and 5 trillion plastic bags annually are disposed globally [12]. While in the seas, not less than 8 million tons of plastic wastes are predicted to get into them annually [13]. In particular, the shores of Nigeria are highly threatened by plastic waste pollution as most of the plastic particles linger for years in the aquatic environment due to their ability to withstand natural degradation processes. These wastes then enter the water bodies from land-based sources such as ground water run-off, combined sewer overflows, cluttering, effluents from the industries, and solid waste disposal and landfills [14].

When plastics are released into the water as sediments, a more harmful concentration is automatically formed as that occurring in sea water. Priority pollutant metals are heavy metals and organic chemical formed by toxic pollutant caused by this plastic waste being deposited in the sea. This pollutant then enters the tissue and skins or can also be consumed by aquatic-life and progresses up the food ladder to man's as consumers by eating this contaminated seafood. Ocean birds are also at risk as they are mostly around the sea either by land on the water surfaces, drinking sea water or consume these contaminated fishes [9]. Gallo et al. [79] also stated that the oceans are been polluted by defoliant everyday either by spillages or by plastic bottles dump on the sea by ships. The plastic wastes in turn releases harmful chemicals. Harmful chemicals such as polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDTs) are forms of defoliant and biological toxic waste consistently found in plastic waste which occurs due to the fact that they are non-polar molecules in nature and repel the water molecules [15]. The experiential forecast that more plastics than fishes may be found in the oceans by 2050, means more dangers and requires drastic measures to address the hazard urgently. For instance, African Development Bank estimated that more than 100,000 aquatic animals die annually because of plastics, while 83 percent of underground portable water sources are contaminated with plastic residues [16]. Plastic disposal into oceans and rivers also leads to suffocation and entanglement of aquatic organisms like fishes, seabirds, turtles, mussels, crustaceans and sea mammals, while plastic ingestion could be so deadly. For example, when aquatic organisms get trapped by plastic pollution, it can lead to lacerations and infections due to abrasiveness of the particles Science for Environment Policy (SFEP), 2011. In addition, it may also prevent the animals from swimming to get food and to escape from danger, thereby leading to mortalities due to either hunger or by predators.

### 2.2. Impact of plastic waste on land pollution

Contaminated plastics can discharge toxic substances into the soil, which could later flow into underground and other water sources in the surroundings. This can cause severe damage to the organisms consuming it water. With several types of plastics, landfill areas are constantly piling up large. There are also many bacteria and pathogens in these landfills that promote the biodegradation of plastics [15]. Land filling and pollution occurs when plastic wastes are not properly disposed of, they are carried by wind or animals and fill up land spaces, drainages, pipes as shown in Figure 1 this chemical then get deposited into the soil, thus



Figure 1. Plastic waste blocking drains.

contaminating crops. The picture below shows PETE bottles blocking a drainage in Nigeria.

Plastics wastes are hardly recycled in Nigeria with less than 12% being recycled and about 80% of these wastes end up in landfills and dump sites [17]. Meanwhile landfills have been reported to contribute about 20% of Green House Gases (GHG) such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), sulphur and nitrogen gases, and fossil fuels [18]. Usually, most of these gases are released via organic matter (e.g. plastics) decomposition, not only are they able to cause landfill fires due to their flammability, they also reduce solar radiation, thereby leading to global warming [16, 19]. Also, leachates from landfills contains heavy metals including lead, cadmium, mercury, pesticides, disinfectants, pharmaceutical wastes, organics and chemicals substances that could contaminate the groundwater. While mixture of toxic substances and decomposing organic matter from landfill sites could also alter the structure and texture of soils, hence hindering good agricultural practices and subsequently impact negatively on biodiversity [20].

### 2.3. Impact of plastic waste on air pollution

In some big cities of Nigeria such as Ibadan, Lagos, Kaduna, Kano etc., it is not hard to experience smog and poor air water due to burning of solid wastes (mainly plastic materials) as a means to waste management. These practices have continued to exist because of lack of enlightenment, ignorance of the effects and lack of waste collection infrastructure and sometimes stubbornness of the people. The painful thing is that they don't realize that the side-effects of plastic waste combustion are airborne particulate emission (soot) and solid residue ash (black carbonaceous colour) which can travel thousands of kilometers, depending on prevailing atmospheric conditions and enter our food chain possess a high potential of causing health and environmental concerns [16].

Plastic burning as an alternative method to plastic waste land filling is destruction, as there are lingering doubts over the possibility of atmospheric emission of harmful chemicals and heavy metals during the process of burning these plastic wastes. For example, plastic waste fumes emit ammonium substances and polyvinyl chloride. While polychlorinated biphenyls (PCBs), dioxins and furans are released into the atmosphere through burning of plastics which in turn bring about excessive possible environmental contamination [21]. Plastic burning is less used for waste management compared to recycling. In addition, toxins released from plastic and food waste combustion can raise danger of heart disease, aggravate respiratory ailments, damages kidney, liver, nervous system, skin, causes cancer and possibly death [22]. Hence measures need to put in place such as recycling to reduce the rate of plastic waste burning in Nigeria.

## 2.4. Impact of plastic waste on land animals

It was recorded that more than 260 species of living organisms and invertebrates are either caught off in plastics or directly ingested them. While man is at great risk if they happen to consume plants and animals that have been infected with toxins from contaminated plastic products or plastic wastes. Animals get exposed to plastics contamination basically via two ways; ingestion and entanglement, although ingestion is more common. However, while large plastics affects land animals via entanglement, micro plastics are contacted via ingestion. Through this ingestion process, chemicals bio-accumulate into the feeding line and hence those at the top of the food chain becomes more threatened Science for Environment Policy [80, 81]. In other cases, plastic waste could attract contaminants, such as persistent organic pollutants (POPs). When this happens, these chemicals are transported to otherwise clean environments and when ingested by wildlife, chemicals are conveyed into the organism's system.

## 2.5. Impact of plastic waste on human life

As reported by Sigler [23], when plastic waste reaches the sea, it either strangulates, kill or contaminate seafood. Animals can easily be poisoned by plastic pollution and thereafter contaminate water sources and human food. Also, by skin absorption, human beings may get infected when they get in contact with chemicals used in plastic production. During most of the plastic production processes, some synthetic substances such as Bisphenol A, phthalates and fire retardants are usually added to give it certain special properties. Meanwhile human health risks can arise from their monomeric building blocks (e.g., Bisphenol A), their additives (e.g., plasticizers) or from a combination of the two (e.g., antimicrobial polycarbonate) [24]. Food and inhalation are considered the main source of exposure to BPA in the human body [25]. Research also shows that Bisphenol A increases the risk of breast cancer, prostate cancer, pains, metabolic disorders, etc. while in women it impaired it can lead to health issues like obesity, endometrial hyperplasia, recurrent miscarriages, sterility, and polycystic ovarian syndrome [26, 27, 28].

## 3. Plastic waste management

Plastic production in the world today, has increased over the past 40–60 years. 2016 recorded a huge figure of 330–350 million tons having Europe singly producing over 59 million tons. In the next 21 years, it will project to twice the figure [2]. The highest portion of our home garbage consist of plastic waste [29]. There are four basic things man needs to survive, Air to breath, water to drink, food to eat and land to stand on. If plastic waste threatens these four basic needs, then a need for plastic waste management is necessary.

The three solid waste management strategies are the 3R (Reduce, Reuse and Recycling) [30, 31], also suggested landfill and Incineration, however, one of the most efficient methods of managing plastic wastes is through recycling. Although, plastic litter comes from developing countries, a small amount comes from Western countries, primarily due to the limited capacity of collection systems and low recycling rates. However, Horodytska et. al, [32] stressed the need for recycling in order to minimize the amount of waste to be disposed to avoid waste from ending up in rivers, oceans and other environments. From the environmental and socioeconomic standpoints, the best answer to the problem of how to manage waste plastic is to recycle it [33].

There are basically two methods of recycling which are primary recycling and secondary or Mechanical recycling is one of the most common method. However, in 2019 alternative methods were stated as Pyrolysis/thermal degradation, catalytic degradation and gasification [34].

- **Primary Recycling:** this is the most common method of recycling; it can also be referred to as the Reuse strategy as it involves the reusing of

plastic products in its original state. Its major advantage is it is easy, simple and very cheap to adopt. Originally, primary recycling was described as the application of producing the same or similar plastic products [35]. The recovered plastic waste is used by introducing performance and characteristic similar to that of the original plastic [36, 37]. However [11, 38, 39], explained that one major disadvantage of the primary method is the limitation to the amount of cycles for each plastic material. An example of primary recycling is where PET recovered from postconsumer bottles is used in the production of new bottles.

- **Mechanical Recycling:** this refers to the processing of plastics waste into secondary raw material or products without significantly changing the chemical structure of the material [40]. It is also the processing of plastic waste into products of different characteristics [41]. In 2020, Sustainable Packaging Coalition referred to Mechanical Recycling as the operations which attempt to recycle wastes from plastics materials through mechanical processes such as grinding, washing, separating, drying, re-granulating and compounding. In mechanical recycling polymers stay intact, this permits for multiple re-use of polymers in the same or similar product effectively creating a closed loop, therefore, only thermoplastic polymers, such as PP, PE, PET, and PVC, can normally be mechanically recycled [42]. It is considered to be the best technology to recycle polyethylene plastic waste materials into virgin raw materials, without altering the basic structure [43].
- **Pyrolysis/thermal degradation:** the process of recovering energy and useful chemicals from plastic waste [44]. Pyrolysis of plastic mixtures, focused on the decomposition of polymers at varying temperatures, enables simultaneous decomposition and classification of polymers [45].
- **Catalytic degradation:** The thermal degradation process and the degradation of catalysts seems to be the same. Main difference in catalyst degradation is the addition of catalysts to pyrolysis reactions to boost conversion, fuel efficiency, increase selectivity and decrease pyrolysis temperature and residence time [34, 46].
- **Gasification:** The method of converting plastic waste to gaseous fuel is gasification. It can also be described as the process of converting the energy value in solid fuel into chemical energy in gaseous fuel. It transforms solid fuel into hydrogen- and carbon monoxide syngas [47]. It is theoretically feasible to remove plastic waste using gasification in fluidized bed technology [48].

### 3.1. Economic advantages of recycled plastic waste

There are numerous advantages to plastic recycling, including energy conservation and greenhouse gas emissions reduction also known as Gasification. It also protects resources such as oil and gas that are not renewable. In addition, recycling provides livelihood in developing countries for millions of people and families, ranging from white collar employments to casual economic activities [15]. The increase in plastic production as waste is not just a challenge to wild and human life but also a major concern to the government [49]. Plastic waste could be recycled and used to produce composite materials. A composite is a material of superior quality arising from the combination of two or more other component materials whose properties are not separately satisfactory for a task [78]. Recycling plastic waste products is the most resourceful approach to managing solid waste, and it could also be perceived as a recent illustration for actualizing the concept of industrial ecology. It can be seen as a business opportunity and used as a solution to creating health. However, before investing in the plastic recycling business, a thorough research comprising of all factors that may directly or indirectly influence the business is necessary. Therefore, a collision of adequate information as much as possible is required [50]. The future of the enterprise must be secured by developing a clear and understandable prospects and picture of the business by the entrepreneur [51]. According

to [52], there are three basic questions that must be answered before creating a business, the first question is “is there availability of the material”? Plastic waste is everywhere, a sitting wealth waiting to be tapped. Secondly “Is the technology and funds available”? Plastic recycling requires heat, pressing, blending which are widely available, and lastly is there availability of recycled products? Yes, there are. Some crucial areas where recycled plastic waste is needed will be discussed in next chapters of this research using either of the various methods mentioned in the previous chapter of this research. The idea of recycling all over the world has been seen as a driving force for socio-economic development due to its broad impact on the environment and being a source of employment creation [53]. According to UNEP [54], waste constitutes an environmental and health hazards around the world which can be overcome through the process of recycling. Many researchers in Nigeria have presented their studies on reduction of plastic in Nigeria; In a bid to reduce the environmental menace caused by plastic and other wastes in Nigeria, a plastic recycling machine was designed and fabricated with Nigeria locally made materials [55]. They concluded that the recycling efficiency of the designed machine was 97%. While another plastic crushing machine was designed and developed for industrial and commercial recycling. The plastic crushing machine was reported to have a recycling output of 82.2% [56]. This high output shows that a large size of plastics have been greatly reduced from the environment. According to a report published by [57], a low-cost waste plastic shredding machine was constructed in order to shred larger plastics to smaller sizes at a very high speed. The study reported that the average percentage of plastic shredded by the machine is 53.2% while 95% PVC plastic was also reported to be shredded by the machine, [58] developed a plastic recycling machine with Nigeria locally sourced materials, and reported a recycling capacity of 30 kg of wastes per hour for the machine. Recently, [59] fabricated a shredding machine for polyethylene terephthalate bottles pelletizer. PET bottles were shredded by the machine into a required size. The maximum recycling efficiency of the machine is 93.73%. The statistics presented in the literatures indicates that a large amount of plastic wastes have been greatly reduced in Nigeria by shredding the plastic wastes into smaller sizes and recycling.

### 3.1.1. Economic benefits of recycled plastic waste in construction

Plastics, which are naturally organic polymers of high molecular mass [4] could be recycled and used as either additives or re-enforcement used in forming composite materials in construction industries. Additives are substances usually added to surfaces of items and other mixtures to join them permanently by an adhesive bonding process [60]. In this method, plastic waste such as chairs, bucket etc., are washed, dried and crushed into powdered form [18]. The powdered plastic are mashed into different sieve sizes and therefore introduced into the construction mixtures as additives [21]. The pulverized plastic and construction mixture are mixed thoroughly and heated to a temperature above 220 °C. what happens during the heating process is, the plastic liquid flows into the pore holes of the mixture and fill it, thereby making the material less porous [18, 21]. Hence, incorporation of pulverized plastic waste materials into concrete mix also increases the mechanical and physical strength of the composite material formed [62]. Jassim [61] also illustrated the possibility of creating plastic cement from plastic waste materials, i.e instead of using cement recycled plastic waste could be used as a binding agent. Furthermore, research shows that the mixture of plastic waste in cement matrix tiles equally improved the physical and mechanical strength of the produced tiles [63]. When plastic wastes are added to bitumen and aggregates for constructing roads could improve the quality of the roads by reducing the moisture absorption and permeability of the road [64], thus making the road more durable and last longer than conventional roads. The utilization of plastic waste has also shown to reduce the cost of materials, absorbs shock load, reduces water absorption and promotes green construction [65]. Another researcher also explained Nigeria has few and insufficient manufacturers of prefabricated components for walling, intermediate flooring and fascias and advised the potentials of

expanded polystyrene (or EPS which are also plastic wastes) for reducing construction waste on job sites to the minimum [66].

### 3.1.2. Economic benefits of recycled plastic waste in architecture

Both the primary method and secondary methods are adopted in recycling plastic waste for Architecture. When we recycle, we reduce or minimize our plastic waste products. A composite material developed from plastic waste possesses important environmental characteristics which includes resource efficiency, energy efficiency thereby reducing the pollution. Recycled plastic waste composite materials can be used to replace materials for lightweight construction due to their light unit weight, high insulation properties and low thermal conductivity [67]. In doing this, the casualties caused by earthquakes and other natural disasters could be reduced. Also, structural designs and pillars are done using Expanded Polystyrene (EPS) are also plastic waste to create patterns for buildings and pillar designs. Expanded polystyrene (EPS) is a prefabricated modular material for walls, floors, stairs, fascias and ornamentation in construction [66].

### 3.1.3. Economic benefits of recycled plastic waste in clothing

Boone [68], stressed the need for an alternate and safer innovation of materials in fashion and textile industries. While it is commonly assumed that textiles derived from natural materials like cotton and silk are far more ecofriendly than textiles made from man-made materials, this appears to be inaccurate in the case of polyester fibre. PETE or PET bottles are found largely around most areas in the country and may cause land filling, while using PET waste the recycling of textile polyester can be developed. Polyester has become the single largest fiber group in worldwide textile production, taking over from cotton with an estimate as high as 52 percent [69]. About 60 to 70 percent of the total production of synthetic fibers worldwide are made up of polyester base fibers [70].

### 3.1.4. Economic benefits of recycled plastic waste in arts and design

Textile recycling is still in its infancy and will be a major challenge for the coming years, however cellulose-based fibers and polycondensation polymers like polyesters and polyamides are most promising [71]. Kim et al. [72] showed the potential of using waste technology to produce intricate and beautiful avant-garde art designs. Plastic waste could also be used for expression art, it could be used to describe an incidence or also as a call or to seek urgent attention. Okoye [73] used her art as an expression for the need for recycling. Wagner-Lawlor [74] also explained how various artists have totally developed numerous of art works with plastics for the purpose of communicating the impact of plastic wastes to modern life. Temitope [75] reported how a man uses plastic wastes and other materials to build sculptures. PET bottle caps could also be used in making art [76].

### 3.1.5. Plastic waste can be sold

Even though the collection of plastic waste materials is challenging, plastic waste could be sold to generate income. In 2018, on the average the quantity of recyclable plastic wastes collected in Covenant University was more than 30% [77], of which if one could expand the area search, a large mass can be found to be sold to recycling companies.

## 4. Conclusion

Plastic waste has become a menace in our society with a lot of increasing challenges every day in Nigeria which cannot be overemphasized alongside her stupendous accelerated poverty rate that poses a serious threat. The most efficient way of managing plastic waste is through recycling which has several potential benefits in various industries like construction and clothing amongst many others. Therefore, the adoption of the various methods explained above would,

1. Reduce the quantity of plastic wastes scattered in our streets and rivers,

2. Create less dependency on the government for funds,
3. Composite/construction materials developed from recycling plastic wastes are more durable, cheap. Finally,
4. Be a platform for wealth creation.

## 5. Perspectives and suggestion for future researches

For years, human activities have caused huge clang on the face of its natural ecosystem. The ecosystem has been unfavorably subjugated by man's introduction of synthetic plastics and the resulting plastic pollution. It is not to completely rule out the benefits of plastics to the society, and in various occasions, plastics and its products have helped to promote modern technology, health and safety. However, generally the use of plastics brings along some costs in form of plastic pollution and its projecting impact and gradually the negatives are beginning to outweigh the positives. The negative consequences of plastics is a problem to life and the environment as a result of exposure to toxic chemicals used in the production of plastics, poor waste management. The toxic effects of plastics waste on human health and environment is very much evident by the most of the literatures. Hence, the government, environmental protection agencies and health care organizations of Nigeria and globally must rise up, take steps and pay attention to sustainable production, use, and disposal of plastics. It is recommended strongly that individuals and corporate bodies take advantage of outlined merits of plastic recycling, while making more areas research into the other subjects.

## Declarations

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