Quest Journals
Journal of Architecture and Civil Engineering
Volume 9 ~ Issue 8 (2024) pp: 01-11
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

Constructing Using Plastic Waste Bricks: A Theory of Waste to Wealth and its Comparative Cost Analysis

Asunogie, Faruk Osigbhemhe[1] and Osamudiame Bankole Bamidele[2]
[1]*Department of Urban and Regional Planning, School of Environmental Studies, AuchiPolytechnic, Auchi, Edo state, Nigeria*
[2]*Department of Building Technology, School of Environmental Studies,Auchi Polytechnic, Auchi, Edo state, Nigeria*

Abstract
Waste in passing, evokes the feeling of negativity, degradation, and unwantedness. It is any substance that is discarded after primary use, or is worthless, defective, and of no use and these includes plastic waste which causes the planet harm and also affecting daily health, productivity. Plastic waste, or plastic pollution, is slow in degrading (taking over 400 years), Therefore, this project aimed at replacing cement with plastic waste in paver blocks to reduce production costs for blocks (as a component of building production) and ensure a cleaner environment. Using the services of scavengers to get waste plastics, Plastics LDPE used were sorted out very carefully and mixed with stone dust aggregate and poured into moles of specific sizes. A design of a sanitary facility was made and the total number of blocks required was estimated for both Paver and Cement. Based on the findings, the study concludes that, Cost efficiency in construction is very possible if we can adopt economically cheaper and locally available building materials like plastic waste materials, that the cost of construction of the same sanitary facility for both male and female, when compared, cost more using plastic waste as against using cement for this study among others. The study recommends that, Mass Collection and Production of Plastic Waste Materials, Public Awareness/ Orientation Programs on the Suitability of Plastic Waste Materials Parver Blocks for Construction, Establishment of Incentive Measures for the Use of Paver Blocks for Construction and Plastic Wastes sorting at Collection Points Incentives in other to join a constructive process of climate effect mitigation.

***R**eceived 06 Aug., 2024; **R**evised 15 Aug., 2024; **A**ccepted 17 Aug., 2024*

I. Introduction

1.1 Background of the study

Waste is any substance that is discarded after primary use, or is worthless, defective, and of no use. The term is often subjective, because what is waste to one need not necessarily be waste to another. Sometimes, the matter is objectively inaccurate, for instance, to send scrap metals to a landfill is to inaccurately classify them as waste because they are recyclable (Konstantinos, et al, 2022). Waste is anything that has outlived its usefulness. The word waste in passing evokes the feeling of negativity, degradation, and unwantedness (Bassey and Akpan, 2020). A common understanding of waste is the unwanted by-products of human activities generated from and within the Environment (Ivanova et al., 2016).

The world generates 2.01 billion tons of municipal solid waste annually and that number is estimated to rise to 3.40 billion tons by 2050. Poor management of waste is not only causing the planet harm through the contamination of oceans, clogging drains, and causing floods but it is also affecting daily health, productivity, and cleanliness of communities. (Kristina, 2023). Worldwide, the biggest producer of waste per capita is Canada. At an estimated 36.1 metric tons per year, this was 10 metric tons more per capita than the United States. Canada produces an estimated 1.33 billion metric tons of waste per year, with 1.12 billion metric tons of this generated by industrial waste (Tiseo, 2023). In all, no African countries rank among the first 10 countries of waste generators.

Solid waste management affects every single person in the world, whether individuals, managing their waste or governments providing waste management services to their citizens. As nations and cities urbanize, develop economically, and grow in terms of population, the World Bank estimates that waste generation will increase. Global mismanagement of waste is currently at 33%, which equates to approximately 2.47 billion tons annually. By 2050, this number is expected to increase to 4.28 billion tons. (World of 8 Billion, 2022).

Most human activities generate waste (Brunner and Rechberger, 2014). In recent times, the rate and quantity of waste generation have been on the increase. A substantial increase in the volume of waste generation began in the sixteenth century when people began to move from rural areas to cities as a result of the Industrial Revolution (Wilson, 2007). This migration of people to cities led to population explosion that in turn led to a surge in the volume and variety in composition of wastes generated in cities (Amasuomo& Baird, 2016). It was then that materials such as plastics, metals, and glass began to appear in large quantities in municipal waste streams (Williams, 2005).

Plastic waste, or plastic pollution, is 'the accumulation of plastic objects (e.g plastic bottles, low-density polyethylene (LDPE) and much more) in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans'(Sabille, Spathi, and Gilbert, 2016). It also refers to the significant amount of plastic that isn't recycled and ends up in landfill or, in the developing world, thrown into unregulated dump sites (Ganesh et al 2014). In the UK, for example, over 5 million tons of plastic is consumed each year and yet only 1 quarter of it is recycled (Nivetha, 2016). The three-quarters that isn't recycled enters our environment, polluting our oceans and causing damage to our ecosystem.

In less developed countries, the majority of plastic waste eventually ends up in the ocean, meaning that marine animals are especially at risk. So much of what we consume is made of plastic (such as plastic bottles and food containers) because it's inexpensive, yet durable (Sabille, Spathi and Gilbert, 2016). However, plastic is slow to degrade (taking over 400 years or more) due to its chemical structure, which presents a huge challenge. Reducing plastic consumption and raising awareness about plastic recycling is crucial if we are to overcome the problem of plastic waste and pollution on our planet.

In most developing countries, including Auchi, poor waste management is attributed to inadequate sanitation education, (Asunogie, Momoh &Osagioduwa, 2022). Waste management is of different concepts, approaches, and hierarchies. Waste management involves scientific, artistic, and technological approaches to waste control, disposal, and conversion to other useful materials beneficial to man and the Environment. The principle of waste management revolves around the "3 Rs", namely, reducing, re-use, and recycling. They are classified according to their desirability in terms of waste minimization. The term "sanitation" has been given various definitions by different authors and is regularly used in various aid programs (Asunogie and Ozekhome, 2022). This therefore suggests that waste management is intertwined with sanitation.

The waste hierarchy aims to extract the maximum practical benefits from products and generate the minimum amount of end waste, (Bassey and Akpan, 2020). Management is the ability to organize and order actions and activities at the right time with the right instrument for effectiveness and coordination. Waste management is the activities and actions required to manage waste from its inception to the final disposal, from the collection, transportation, treatment, and disposal of waste, together with monitoring and regulation of the waste management processes (Ivanova et al., 2016). It is intended to reduce the adverse effect of waste on human health, the Environment, or aesthetics. Waste management processes are approached at different levels.

The fact is, we simply cannot cope with the amount of plastic on our planet nor the amount that continues to be produced. For this reason, this project is aimed at converting these plastic wastes into useful resources. Hence, reducing their environmental threat and hazard. Therefore, this project aimedat replacing cement with plastic waste in paver blocks to reduce production costs for blocks (as a component of building production) and ensure a cleaner environment. This was achieved through the collection of LDPEs within and around the study area, melting and mixing of LDPEs with coarse aggregate in a precast mole of specific size, evaluate the construction cost comparison between LDPE paver blocks, and expected cost of construction using cement and share the findings with the academic community for mass production and adoption. This is necessary because this research believes that the production of paver blocks from LDPE-bonded sand can have major social, public health, and environmental benefits. By transforming waste plastics into a valuable resource this simple technology has the potential to generate local employment, clean up the environment, produce new construction materials, and significantly reduce the amount of waste LDPE entering the oceans.

1.2 The Research Problems

Plastic products like bottles, polyethylene bags, and others constitute environmental problems for human health and the general environment. This is so because of the space occupied by these wastes when sent to condemnation arising from inadequate solid waste management, with low waste collection rates, disposal primarily by dumping, and limited outlets for reusing potentially recyclable materials according to Wilson et al., (2015).

Besides, the level of environmental sanitation in Auchi is often considered among the poorest in Nigeria. Akpan, (2020). submitted that some residents dump waste indiscriminately into open places, drains, and gutters, thereby choking the drainage and creating fertile grounds for breeding mosquitoes. Almost every available open space is littered with garbage arising from numerous activities. This problem is worsened by two factors: first, the rapid socioeconomic development of Auchi, which pulls migrants from different parts of rural areas of Nigeria, and second, the increasing population of the city. Resulting from the influx.

The principle of waste management revolves around the "3 Rs", namely, reducing, re-use, and recycling. They are classified according to their desirability in terms of waste minimization according to Bassey and Akpan, (2020). Sadly, these 3Rs do not exist in the study area and plastic products are constantly being in use leading to the constant generation of plastic wastes and a constant plastic environmentally-contaminated environment

Research all over shows that plastic waste production or generation is directly proportional to plastic product production. Unfortunately, large percentages of the plastic waste generated in Auchi Polytechnic and its environs are not recycled. Instead, much of it ends up in water bodies – rivers, lakes, drains, and on the ground around the environment, which comes in sizes ranging from macro plastic (pieces larger than 25 millimeters in diameter) to Nano plastic (less than 1,000 nanometers), (Wilson et al, 2015).

1.3 The Concepts and Frame Behind the Study

1.3.1 The Theory of Waste To Wealth

Waste-to-Wealth means moving waste from a platform of exhausted utility to a valuable and desirable level. The concept of Waste-to-Wealth means moving the waste from a platform of exhausted utility to a valuable and desirable level where it gets further appreciation or value. Its transformation: in engineering, requires some form of energy, and in economics requires a factor of production (Adetola, et al, 2021). The latent issue here is that "waste" in itself can never be wealth otherwise generator will never discard it. Likewise, wealth is created and the process of creating wealth has some cost implications that the market forces construe as the price. This means that not all wastes are potentially of secondary benefit. In all, the slogan "waste-to-wealth connotes that waste management operations must transcend the delivery of service to the provision of goods or values like energy (Egun, 2012).

When waste is collected with skill and care, and upgraded with quality in mind, discarded materials are a resource that can contribute to local revenue, job creation, business expansion, and the local economic base. On a per-ton basis, sorting and processing recyclables alone sustain 10 times more jobs than landfilling or incineration according to Clark County Solid Waste Management Plan, (2015). Making new products from the old offers the largest economic payoff in the recycling loop. New recycling-based manufacturers employ even more people and at higher wages than does sorting recyclables. Additionally reuse, recycling and composting can reduce significant amounts of resources and energy used in the manufacture, distribution, and sale of products to consumers.

1.4 THE CONCEPT OF SUSTAINABLE DEVELOPMENT

Development is defined as 'an evolutionary process in which the human capacity increases in terms of initiating new structures, coping with problems, adapting to continuous change, and striving purposefully and creatively to attain new goals (Peet, 1999 cited in Du Pisani, 2006). According to Reyes (2001), development is understood as a social condition within a nation, in which the needs of its population are satisfied by the rational and sustainable use of natural resources and systems.

Todaro and Smith (2006) also define development as a multi-dimensional process that involves major changes in social structures, attitudes, and institutions, as well as economic growth, reduction of inequality, and eradication of absolute poverty. This therefore makes sustainable development, which can only create avenues and opportunities for development (be it any form) that must not compromise the ability of future generations to benefit from the same opportunity when their time eventually comes. In other words, a development that can be continued either indefinitely or for a given period according to Stoddart, et al (2011).

II. Literature Review

2.1 The Concept of Waste

The world generates 2.01 billion tons of municipal solid waste annually and that number is estimated to rise to 3.40 billion tons by 2050. Poor management of waste is not only causing the planet harm through the contamination of oceans, clogging drains, and causing floods but it is also affecting daily health, productivity, and cleanliness of communities. (Kristina, 2023). Waste is any substance that is discarded after primary use, or is worthless, defective, and of no use. The term is often subjective, because what is waste to one need not necessarily be waste to another. Sometimes, the matter is objectively inaccurate, for instance, to send scrap metals to a landfill is to inaccurately classify them as waste because they are recyclable (Konstantinos, et al, 2022). Waste is anything that has outlived its usefulness. The word waste in passing evokes the feeling of negativity, degradation, and unwantedness (Bassey and Akpan, 2020). A common understanding of waste is the unwanted by-products of human activities generated from and within the Environment (Ivanova et al., 2016).

Waste could be domestic, industrial, chemical, biological, or toxic, depending on the source. Suffice it to mention that the world is full of human activities that have a significant impact on the Environment, negatively or positively, depending on the mode of utilization, expression, or exploitation. The human activities effect increases waste production, arising from rapid population growth, exploitation, and utilization of human and natural resources (Seik, 1997). Man lives in an environment that poses complex problems. However, for him to survive in this Environment, he must be able to solve several problems. This may include overcoming the threats posed by environmental waste (Hilson, 2002). One such complex problem is environmental waste, which threatens human health and survival. It is worthy of note that efforts have been made are efforts towards curbing the menace of waste for environmental sustainability (Courchamp et al., 2017).

2.2 Waste Management

Waste is regarded as undesirable and worthless material. In most developing countries, including Auchi, poor waste management is attributed to inadequate sanitation education, (Asunogie, Momoh &Osagioduwa, 2022). Waste management is of different concepts, approaches, and hierarchies. Waste management involves scientific, artistic, and technological approaches to waste control, disposal, and conversion to other useful materials beneficial to man and the Environment. The principle of waste management revolves around the "3 Rs", namely, reducing, re-use, and recycling. They are classified according to their desirability in terms of waste minimization. The term "sanitation" has been given various definitions by different authors and is regularly used in various aid programs (Asunogie and Ozekhome, 2022). This therefore suggests that waste management is intertwined with sanitation. The waste hierarchy aims to extract the maximum practical benefits from products and generate the minimum amount of end waste, (Bassey and Akpan, 2020). Management is the ability to organize and order actions and activities at the right time with the right instrument for effectiveness and coordination. Waste management is the activities and actions required to manage waste from its inception to the final disposal, from the collection, transportation, treatment, and disposal of waste, together with monitoring and regulation of the waste management processes (Ivanova et al., 2016). It is intended to reduce the adverse effect of waste on human health, the Environment, or aesthetics. Waste management processes are approached at different levels. Governmental, municipal solid waste is where the government handles the bulk of the waste created by household, industrial, and commercial actions. The Federal Government of Nigeria has also placed a legal framework aimed at curbing environmental degradation, (Bassey and Akpan, 2020).

2.3 Low-density polyethylene (LDPE) as Wealth

Low-density polyethylene (LDPE) bonded sand is a resource-efficient material that can transform wasted low-density polyethylene (LDPE) into a valuable local resource. Water sachets made from LDPE are a problem because there are often very limited recycling options for this material and they hurt public health and the environment. LDPE water sachets and other sources can be used to form LDPE-bonded sand. This requires simple processing and produces a durable, relatively lightweight material. No water is required in the production process. A relatively simple technology has been developed in Cameroon that produces LDPE-bonded sand blocks and pavers. The application of this technology is an example of a community-driven waste management initiative that has the potential to impact the global plastics waste crisis because it can transform waste LDPE and other readily available types of plastics into a valuable local resource.

Developing countries typically have inadequate solid waste management, with low waste collection rates, disposal primarily by dumping, and limited outlets for reusing potentially recyclable materials (Wilson et al., 2015). However, waste materials in developing countries can provide livelihoods to a highly entrepreneurial informal sector (Wilson et al., 2006). The management of wastes, and particularly waste plastics, has become a high profile, environmental and public health issue. Recycling infrastructure for these materials often does not exist in developing countries, and as a result, waste plastics have little or no value, resulting in uncontrolled disposal. Dumping into waterways has severe adverse effects on local communities. Waste plastics are not only unsightly, but they block urban drainage systems and sewers, causing flash floods, as well as providing a fertile breeding ground for mosquitos and other waterborne diseases. 56,000 tons of plastic waste were developed in India as of 2017. The dumped waste polluted the surrounding environment. As a result, it affects both humans and animals in direct and indirect ways. Hence it is necessary to dispose the plastic waste properly as per the regulations provided by our government. The replacement of plastic waste for cement provides potential environmental as well as economic benefits.

2.4 Plastic Paver Blocks: Strength and Weakness

Plastic is a very remarkable human invention; nevertheless, due to its non-biodegradable nature, it has several severe environmental effects (Bawar et al, 2023). Plastic pollution has now become the largest substantial danger to modern society, causing environmental deterioration and economic harm (Saikia and De

Brito, 2012). The large volume of plastic debris amassing in the ecosystem has posed a threat to several marine species and environmental sustainability.

Different studies have shown the capabilities within the plastic paver blocks using a Compressive Testing Machine (CTM) to determine the compressive strength of all the samples. The study discovered that as the size of sand particles decreased, there was an increase in the compressive strength. Thus, using finer sand with a diameter of less than 0.42 mm in manufacturing LDPE-sand PB is significantly more advantageous than coarser sand (Bawar et al, 2023). With the view to investigate the behavior of quarry rock dust, recycled plastic, and the production of plastic paver blocks from solid waste, a critical review of the literature was taken up. An attempt was made by Nivetha, et.al (2016) to reuse the solid waste quarry dust fly ash and PET with an aim not to lose the strength far from the original Paver blocks. From the observations of test results, Polyethylene Terephthalate - PET can be reused with 50% of quarry dust and 25 % of fly ash in a Plastic Paver block. The physical and mechanical properties of materials used in the Plastic Paver block were investigated. For the test 6 cubes were cast for measuring Compressive strength.

Three replacement levels of 10 %, 20 %, and 30% by weight of aggregates were used for the preparation of the concrete. Some scholars discussed cement concrete paver blocks for rural roads. The study of Joel and Ravikant, (2015) indicated that fly ash and waste glass powder can effectively be used as cement replacement without substantial change in strength.

2.5 Plastic: Its Quantity and Its Impact On The Marine Environment

The threat from plastic pollution has grown from a minor environmental nuisance and niche scientific issue to a major global environmental concern that is attracting considerable and sustained interest from researchers, the media, the public, and decision-makers. In 2019, the United Nations referred to it as a ‘planetary crisis’ (MacLeod et al., 2021; Villarrubia-Gomez et al., 2018).

The world generates 2.01 billion tons of municipal solid waste annually and that number is estimated to rise to 3.40 billion tons by 2050. Poor management of waste is not only causing the planet harm through the contamination of oceans, clogging drains, and causing floods but it is also affecting daily health, productivity, and cleanliness of communities. (Kristina, 2023). Worldwide, the biggest producer of waste per capita is Canada. At an estimated 36.1 metric tons per year, this was 10 metric tons more per capita than the United States. Canada produces an estimated 1.33 billion metric tons of waste per year, with 1.12 billion metric tons of this generated by industrial waste (Tiseo, 2023).

According to Rahman et al, (2023), Aquatic ecosystems are interconnected with the terrestrial environment; therefore, changes in one system have impacts on another. For decades, different factors, including anthropogenic activities, have stressed the coastal and marine ecosystems (Adams, 2005; Richmond, 2015). Compared with other categories of debris such as glass, cloth, paper, food waste, metal, rubber, medical/personal hygiene-related items, smoking/firework items, and wood (Nualphan, 2013; Rosevelt et al., 2013), plastic litter is persistent in the ocean basins due to unique characteristics of plastics (e.g., the potential of ready transportation by water current and wind due to long shelf-life). Plastic debris with counts of five trillion, weighing more than 260,000 tons, is floating over the world's ocean surface as a result of improper waste disposal (Eriksen et al., 2014). Currently, plastic pollution has become a serious concern over almost all parts of ocean basins, irrespective of developed or underdeveloped regions in the world (Thushari and Senevirathna, 2020).

All kinds of marine plants, from apex predators down to the plankton at the base of the food chain, ingest plastics. These can cause severe harm to the animals, affecting food uptake by creating a false sense of satiation or blockages in digestive systems, as well as leading to internal damage (Rahman et al, 2023). Several studies in laboratory experiments have shown reduced growth in fish when their food is contaminated by higher amounts of microplastics; (Naidoo and Glassom, 2019) while at the other extreme a single plastic drinking straw in its digestive system likely caused the death of a whale shark in Thailand (Haetrakul et al., 2009).

All the ingredients in plastics are not harmful, but many of them are and can leach from plastics (Rochman, 2015) into the marine ecosystem. The smallest plastic particles can cross into the body cells and some of them can even reach the brains of marine animals (Mattsson et al., 2017; Prüst et al., 2020), and cause severe health hazards. The effects of plastic on marine ecosystems should not be considered separately. Plastic pollution is one of several manmade threats including ocean warming, overharvesting, ocean acidification, eutrophication, deoxygenation, shipping and underwater noise, invasive species, habitat destruction, and fragmentation, as well as other forms of chemical pollution (Rahman et al, 2023). Although plastic pollution is now found everywhere in the global ocean, certain key marine and coastal ecosystems are particularly at risk as they are already facing multiple threats in addition to growing levels of plastic pollution. These ecosystems – coral reefs and mangroves are notable examples – provide vital services to people as well as marine life, so humans are directly affected when plastic negatively affects how they function (Gall and Thompson, 2015).

III. Research Methodology

The study employed the services of scavengers to get waste plastics for the study. In other to allow for easy access to these wastes, the study did not fix a perimeter area within which the plastics waste were to be collected and sorted. Based on the findings of Nivetha, et.al (2016), Plastics LDPE used were sorted out very carefully. Different plastics melt and burn at different temperatures, so it was important to be certain we only had one kind of plastic. This process used LDPE (Low-Density Polyethylene).

The plastic bag used is about 50 microns. The basic properties are Melting point with 150^o value, Thermal coefficient of expansion with the value of 100-200 X 106, Density with a value of 0.910 to 0.940, and Tensile stress with a value of 0.20 to 0.40(N/mm2). Quarry dust Crushed sand of less than 4.75 mm is produced from the rock using the state of crushing plants. Production of quarry fines is a consequence of extraction and processing in a quarry and collected from the nearby quarry. Properties Of Quarry Dust are Specific gravity 2.62 with a value of 2.62, Grading zone with a value that is dependent on the soil, Fineness modulus with a value of 2,952, and Water absorption with a value of 1.80

A relatively deep drum was used for melting (see Figure 1.0). The size of the drum used was 80cm wide and 50cm deep. The temperature was Kept below 85^o C so the plastic does not burn. Plastic wastes collected were poured into the drum and allowed to melt under a conditioned temperature. All plastics were allowed to melt until they turned liquid for about 20 minutes. A measured amount of Sand was then poured in slowly and stirred continuously until the mixture looked like cement.

Fig 1.0: 50ºC to 80ºC Melting Drum

The mold and table were oiled to avoid sticky reactions. The mixture was then poured into the block mold and proper leveling was done to avoid inequalities and achieve actual block sizes and weight. The cast plastic was allowed to be set for a space of two minutes before they were removed from the mold.

A design of a sanitary facility was made and the total number of blocks required was estimated at approximately 1,750 paver blocks with a size of 75mm by 75mm by 225mm. The total number of blocks required for the construction of a sanitary facility has been made. The waste plastic blocks were allowed to cure for a space of 12-24 hours and then ready to use.

IV. Findings

This research aimedat replacing cement with plastic waste in paver blocks to reduce production costs for blocks (as a component of building production) and ensure a cleaner environment.Thus some key findings made as follows.

From the study, it was revealed that waste plastics were abundantly available for positive or negative use depending on the need of a user. It showed that during collection/ scavenging process, 56.3% of plastic wastes collected were used/empty bottle water or drinks, 23.1% of plastic wastes collected were plastic plates and rubbers, 13.9% of plastic wastes collected were nylon waste and 6.7% of plastic wastes collected were fell under other categories as grouped. This is shown in figure 2.0.

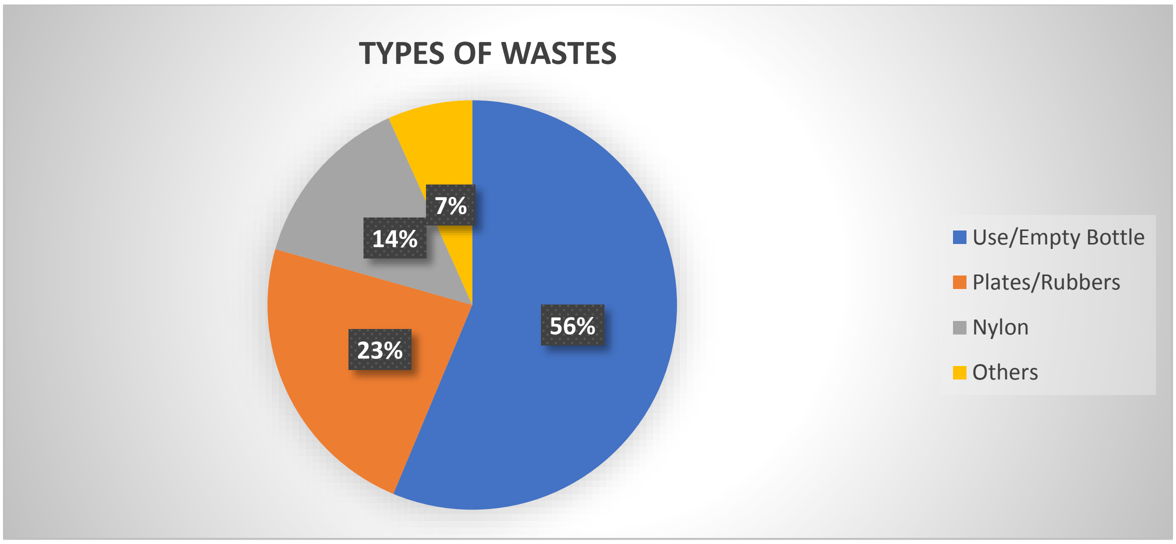

Figure 2.0: Types Of Wastes Collected (*Source: Author's Survey, 2024)*

Findings from the study also revealed that 72,1% of collected wastes materials were very useful, 19,4% of collected wastes materials were partially useful and only 8.5% of collected wastes materials were not useful at all. This was so due to the required temperature needed to melt the different level/types of plastics. This is shown in figure 3.0.

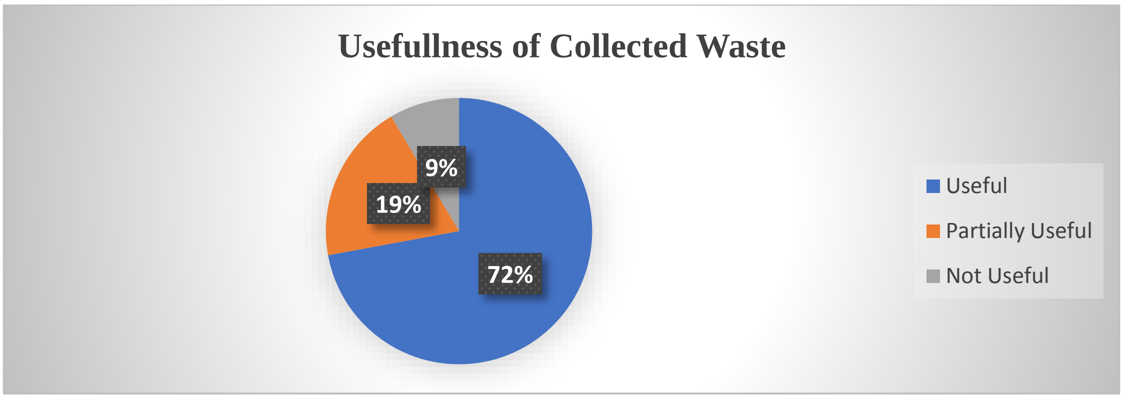

Figure 3.0: Usefulness of Collected Wastes (*Source: Author's Survey, 2024)*

Findings on the cost of collection of waste materials for the study showed that 27% of waste collected per ton cost ₦1,800, 23% of waste collected per ton cost ₦1,900, 26% of waste collected per ton cost ₦2,000 and 24% of waste collected per ton cost ₦2,100 this is shown in figure 4.0. This gives us an average cost of waste plastic per ton at ₦1,950.

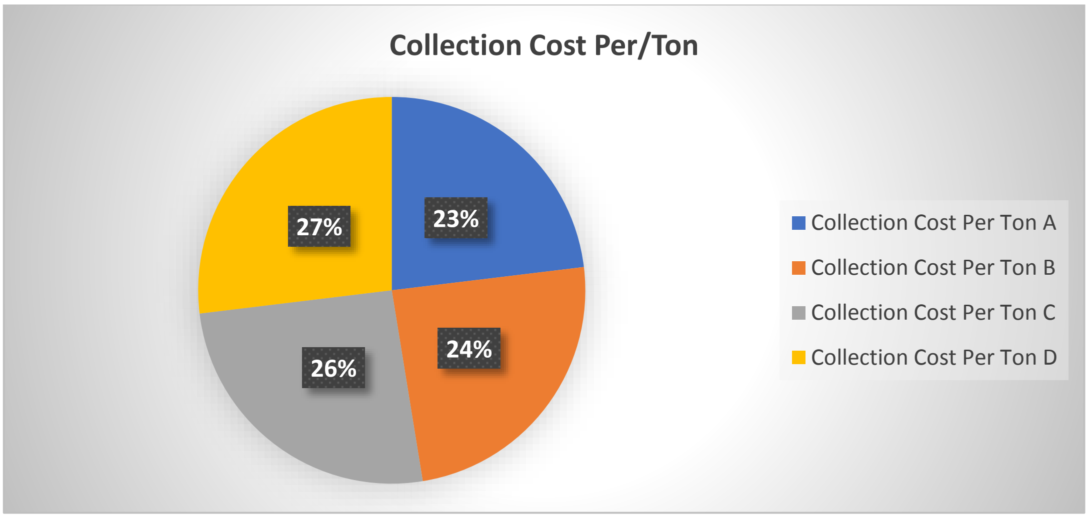

Figure 4: Cost of collection of waste materials (Source: Author's Survey, 2024)

The study also showed that 37.2% of a tone of waste plastic material, when melted and mixed with stone dust aggregates produced 20 paver blocks, 41.1% of a tone of waste plastic material, when melted and mixed with stone dust aggregates produced 23 paver blocks and 21.7% of a tone of waste plastic material, when melted and mixed with stone dust aggregates produced 25 paver blocks. This gives us an average of 22 paver blocks when the different types of waste plastics materials are collected together and used for paver block making. This is shown in Table 1.0

Table 1.0: Plastic Waste Materials/ Paver Blocks Produce.

TOTAL WASTE MATERIAL PER TON	TOTAL PAVER BLOCKS PRODUCED	AVERAGE OF PAVER PER TON
37.2%	20	18
41.1%	23	21.5
21.7%	25	23

Source: Author's Survey, 2024

A comparative evaluation by this study showed that 50kg of waste plastic material when scaled gives us and average of 5,000 plastic bottles, that 100 plastics gives us 1 paver block, 2,500 plastic gives use 25 paver blocks. Therefore 5,000 plastics gives us 50 paver blocks when mixed with stone dust aggregate. The study also revealed that 2,000 plastic bottles give us 1 ton, while 50kg Cement when mixed with stone dust aggregate gives 150 blocks of the same size. Thus, it was shown that 175,000 plastic bottles produced 1,750 paver blocks needed for the study. This gave us a production cost of ₦170,625 from the production of 175,000 plastics. This can construct a simple sanitary facility for both males and female respectively.

Table 2.0: Weight of Plastic Needed for Paver Block Production

WEIGHT OF PLASTIC WASTE	QUANTITY OF WASTE PLASTIC	NUMBER OF PAVER BLOCKS
87.5ton	175,000	1,750
50kg	5,000	50
10kg	1,000	10
1kg	100	1

Source: Author's Survey, 2024

The study also revealed, based on observationthat, a bag of cement currently costs ₦8,000. Experimentation further showed that a bag of cement can produce 30 blocks when mixed with stone dust sand. Based on the evidence gathered above, it therefore implies that, to construct same sanitary facilities for both male and female using cement blocks, 20 bags of cement will produce 600 blocks required to get the job done. This is estimated to cost ₦160,000.

Findings from the study also revealed that for every ton of plastic recovered and reuse for this study, every 300m^2 land area gets cleaner by 45% thereby reducing the level of environmental waste within such environment. This therefore implies mathematically that an average of about 26,250m^2 of land area have become at least 45% cleaner and better for the environment in general.

Findings from other studies also revealed that for every 7% reduction of the number of plastics waste materials that find their way in to the drains, rivers and ocean, there is a directly proportional chances of a positive life improvement, survival and or expectancy rate for aquatic and marine animals as they are most threatened by plastic wastes that finds their way in to such water bodies. Thus, it therefore revealed that this study reuse of the 87.5tons of plastic waste is a remarkable improvement on the life of water/ aquatic organism and their ecosystem in particular.

This study, however, revealed that the direct cost of construction of the sanitary facility using plastic waste materials as blocks for the process was more expensive when compared with the use of cement as a construction material. This finding did not take into account the environmental advantage derived from the extraction of the waste of the environment.

It also revealed that the cost of construction of blocks for construction purposes using plastic waste is more expensive when the production process is small. This therefore implies that where theproduction process is scaled up for mass production, cost of production will drop and make it a cheaper alternative to cement beyond its environmental advantage to both man and animal.

4.1 **Summary of Findings**

With the aim of replacing cement with plastic waste in paver blocks to reduce production costs for blocks (as a component of building production) in other to ensure a cleaner environment, the summary of major findings are hereby made below.

From the findings, it is safe to summarize that waste plastics were abundantly available within the study area including the different types of plastic wastes like plastic bottle for drinks and other type of liquid; That all collected plastic wastes materials were useful for the study with variations in their quality or degree of usefulness when carefully separated; That the cost of collection of waste materials per ton ranged from ₦1,800, ₦1,900, ₦2,000 and ₦2,100. Thus, giving an average cost of waste plastic per ton at ₦1,950; That based on the quality of the plastic wastes collected and sorted, 37.2% of a tone of waste plastic material, produced 20 paver blocks, 41.1% of a tone of waste plastic produced 23 paver blocks and 21.7% of a tone of waste plastic material produced 25 paver blocks; That a comparative evaluation showed that 50kg of waste plastic average of 5,000 plastic bottles, that 100 plastics gives us 1 paver block, 5,000 plastics gives us 50 paver blocks, that 2,000 plastic bottles give us 1 ton, while 50kg Cement gives 150 blocks of the same size and 175,000 plastic bottles produced 1,750 paver blocks needed for the study, with a production cost of ₦170,625 which can construct a simple sanitary facility for both males and female respectively; That, a bag of cement currently costs ₦8,000which can produce 30 blocks when mixed with stone dust sand and that, to construct same sanitary facilities for both male and female using cement blocks, 20 bags of cement will produce 600 blocks required to get the job doneestimated to cost ₦160,000; That for every ton of plastic recovered and reuse for this study, every 300m^2 land area gets cleaner by 45%. Therefore, an average of about 26,250m^2 of land area have become at least 45% cleaner and better for the environment in general as a result of the implementationof this study; That for every 7% reduction of the number of plastics waste materials that find their way in to the drains, rivers and ocean, there is chances of a positive life improvement, survival and or expectancy rate for aquatic and marine animals. Thus, meaning that this study's reuse of the 87.5tons of plastic waste is a remarkable improvement on the life of water/ aquatic organism and their ecosystem in particular and: That the direct cost of construction of the sanitary facility using plastic waste materials as blocks for the process was more expensive when compared with the use of cement as a construction material but where the production process is scaled up for mass production, cost of production will drop and make it a cheaper alternative to cement beyond its environmental advantage to both man and animal.

V. Conclusion

Based on the major finding of this study, the study can safely conclude that

1. Cost efficiency in construction is very possible if we can adopt economically cheaper and locally available building materials like plastic waste materials, thereby reducing the usage of high quantity of conventional building materials and components in line with Anujith, et al, (2019). This option creates an opportunity to meet global sustainable development targets and climate change/adaptation issues bedeviling the world today.
2. That the use of waste plastic materials for the construction of structures like residential, commercial and public use structures can generate remarkable and considerable positive benefits to man and the environment as this will conserve the need and pressure on cement as a constituent of the building process, ensure sustainable development and negative climate change reduction since it creates the opportunity to recycle waste and turn them to wealth and reduce emissions that would have arisen from cement manufacturing processes.

3. That the cost of construction of the same sanitary facility for both male and female, when compared, cost more using plastic waste as against using cement for this study. But will cost less when plastic waste paver blocks are mass produced due to cost of production efficiency.

VI. Recommendations

The study was aimed at replacing cement with plastic waste in paver blocks to reduce production costs for blocks (as a component of building production) in other to ensure a cleaner environment as a means to reducing the effect of climate change. Based on the conclusion above, the following is hereby recommended.

1. Mass Collection and Production of Plastic Waste Materials: The collection and production of plastic wastes for the purpose of mass-producing paver blocks will make it a profitable business for any one or group that choses to invest in this line of business. This will spread the cost of production to a relatively large volume of paver blocks to make the process economically viable business, thereby making it cheap at the point of purchase for use by whoever wishes to construct with it. For this to happen, relevant government and not-governmental agencies may have to create incentive opportunities for would-be investors. Such opportunity may include a relatively low interest rates on loans and grants aimed at setting up such business opportunities. It may also extend to the duration of payment for such loans or grants in other to create a very soft repayment process that would be attractive to investors and or business minded persons.
2. Public Awareness/ Orientation Programs on the Suitability of Plastic Waste Materials Parver Blocks for Construction: There is need for public awareness by different stakeholders therein. This is aimed at painting positive pictures in the mind of the general public that will start the process of buy-in into paver blocks for construction as an alternative construction material within the built industry. This awareness must be focused towards amplifying the suitability of paver blocks from plastic waste for building construction.
3. Establishment of Incentive Measures for the Use of Paver Blocks for Construction: this is important and different from the first recommendation as it is targeting those who have eventually agreed to go into such business. This is important because there is utmost need to keep such persons in business in other to continually reduce the quantity of plastic waste materials that are already running riot in our environment. For this model to fly, incentives like Tax rebate for such businesses, Tax exemption are likely to attract would-be investors. These types of incentives can create the basis and opportunity for relevant agency of government to regulate the price of sales of such paver blocks. Thereby putting such product under a price control
4. Plastic Wastes sorting at Collection Points Incentives:There is utmost need for the creation or establishment of financial incentives for plastic wastes collection at the micro unit level of every settlement. This will mean getting paid for every unit of plastic waste materials properly sorted and separated from other waste at generation point by government or its agencies and or any other relevant stakeholder(s) in the business of combatting climate change effects among other. More so, the household is the smallest unit but most populated unit of waste generation. So, when these pointes are targeted and rewarded, there is likely to be better efficiency in collection of plastic wastes. This is imperative since waste collection is easier at generation point during waste management process. This model will not only ensure that no plastic waste material get missing at generation points, it also ensures that it is properly sorted and separated from every other type of waste that is like to be generated at the point of generation.

References

[1]. Anujith, S., Shahana, S., Subahan, S., Thasneem, A., and Abibasheer, B. (2019). Cost Effective Residential Building Using Plastic Bottles - A Home for the Future. International Journal of Emerging Technologies in Engineering Research (IJETER) 7(6) 5 – 13

[2]. Ashraf A., 2016. Thermal conductivity measurement by hot disk analyser. <https:// www.researchgate.net/publication/271840994> (accessed 13.8.17).

[3]. Asunogie, O.F &Ozekhome, M.C. (2022). Sanitary Facility for Urban-Public Use and Management – The Need for One in Area-3 of Auchi Polytechnic, Auchi, Edo State. International Journal of Scientific Research and Engineering Development-– Volume 5 Issue 2 (630 - 641)

[4]. Asunogie, O.F., Momoh, S., &Osagioduwa, M. (2022). Public Opinion on Auchi's Solid Waste Management. Direct Research Journal of Public Health and Environmental Technology: Vol. 7(7) 85 - 94.

[5]. Awaja, F., Gilbert, M., Kelly, G., Fox, B., Pigram, P.J., 2009. Adhesion of polymers. Prog. Polym. Sci. 34, 948–968.

[6]. Bassey, A. B. and Akpan, R. W. (2020). The arts of converting waste to wealth: towards environmental sustainability in Nigeria. Central Asian Journal of Environmental Science and Technology Innovation 1(3): 159-167.

[7]. CHUDLEY, R., GREENO, R., Butterworth & Heinemann (2007) 'Building Construction Handbook' (6th ed.).

[8]. Consoli, N.C., Montardo, J.P., Prietto, P.D.M., Pasa, G.S., 2002. Engineering behavior ofa sand reinforced block with plastic waste. J. Geotech. Geoenviron. Eng. 128, 462–472.

[9]. Courchamp, F., Fournier, A., Bellard, C., Bertelsmeier, C., Bonnaud, E., Jeschke, J.M., Russell, J.C., (2017). Invasion biology: specific problems and possible solutions. Trends. Ecol. Evol., **32**(1), 13-22. https://doi.org/10.1016/j.tree.2016.11.001

[10]. Electrical services for building construction https://epdf.pub/design-of-electrical-services-for-buildings-4th-edition.html

[11]. Fewtrell L, Kaufmann R.B., Kay D., Enanoria W., Haller L., and Colford, J.M.C., Jr. (2009) Water, sanitation, and hygiene interventions to reduce diarrhea in less developed countries: A systematic review and meta-analysis, The Lancet Infectious Diseases, Vol. 5, Issue 1: 42–52

[12]. Ganesh Tapkire. Satish Parihar. PramodPatil. Hemra, R.Kumavat. (2014). Recycled Plastic used in Concrete Paver Block. International Journal of Research in Engineering and Technology, 3(09).

[13]. Gu, L., Ozbakkaloglu, T., 2016. Use of recycled plastics in concrete: a critical review. Waste Manage. 51, 19–42. Hassn, A., Aboufoul, M., Wu, Y.,

[14]. Hilson, G., (2002). The environmental impact of small-scale gold mining in Ghana: identifying problems and possible solutions. Geogr. J., **168**(1), 57-72. https://doi.org/10.1111/1475-4959.00038

[15]. Ivanova, D., Stadler, K., Steen-Olsen, K., Wood, R., Vita, G., Tukker, A., Hertwich, E.G., (2016). Environmental impact assessment of household consumption. J. Ind. Ecol., **20**(3), 526-536. https://doi.org/10.1111/jiec.12371

[16]. Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan,R., Law, K.L., 2015. Marine pollution. Plastic waste inputs from land into the ocean. Science 347, 768–771.

[17]. Joel Santhosh. RavikantTalluri. (2015). Manufacture of Concrete Paving Blocks with Fly Ash and Glass Powder. International Journal of Civil Engineering and Technology, 6(4), 55-64.

[18]. Kivrak, S., Tuncan, M., Onur, M., Arslan, G., Arioz, O., 2006. An economic perspective of advantages of using lightweight concrete in construction. Our world in concrete and structures. [Online] http://www.cipremier.com/page.php?377 (accessed 13.8.17).

[19]. Konstantinos K., Dimitrios E. A., Efstathios K., Kyriaki K., Junior L., Nickolas J. T. and Constantinos S. P. (2022). Transforming Waste to Wealth, Achieving Circular Economy. Circular Economy and Sustainability 2:1541–1559.

[20]. Kristina, N. J. (2023). How do we turn waste to wealth? Edited by Danish Architecture Center. Nordic Innovation, Stensberggata 27, NO-0170 Oslo. www.nordicinnovation.org. retrieved on 9th June,2023

[21]. Lenkiewicz, Z., Webster, M., 2017. Making waste work: a toolkit, community waste management in middle- and low-income countries. [Online] <https://wasteaid.org.uk/toolkit/making-waste-work/>.

[22]. Nivetha, C. Rubiya, M. Shobana, S. Vaijayanathi, G. (2016).Production of Plastic Paver Block from the Solid Waste. ARPN Journal of Engineering and Applied Science. 11(2).

[23]. Poonam Sharma. Ramesh kumarBatra. (2016). Cement Concrete Paver Blocks for Rural Roads. International Journal of Current Engineering and Scientific Research, 3(1), 114-121.

[24]. Sebille, E., Spathi, C., Gilbert, A., 2016. The ocean plastic pollution challenge towards solutions in the UK. Grantham Institute Briefing paper No. 19. [Online] <www.imperial.ac.uk/grantham/publications> (accessed 10.8.17).

[25]. Seik, F.T., (1997). Recycling of domestic waste: early experiences in Singapore. Habitat. Int., **21**(3), 277-289. https://doi.org/10.1016/S0197-3975(97)00060-X

[26]. WHO (2005) Sustainable Development and Healthy Environments, Water, Sanitation and Health, Geneva, World Health Organization

[27]. Wilson, D.C., Rodic, L., Modak, P., Soos, R., Carpintero, A., Velis, C., Iyer, M., Simonett,. Global Waste Management Outlook. Report. UNEP DTIE, ISBN: 978-92-807-3479-9. 2015.