Quest Journals
Journal of Research in Humanities and Social Science
Volume 11 ~ Issue 1 (2023) pp: 317-325
ISSN(Online):2321-9467
www.questjournals.org

Research Paper

Recycling and Processing Of Plastic Waste into Plastic Tile a Step towards Sustainability in Abuja Municipal Area Council Federal Capital Territory, Nigeria

O. Mohammed, A.T. Ogah and A. Mahnoud
Nasarawa State University, Keffi Nasarawa State
Corresponding: O. Mohammed

ABSTRACT: *This study has been undertaken to investigate the use of plastic waste for preparation of plastic tiles which can be recycle the plastic waste. Plastics due to their versatile nature are being widely employed in human lives. With the increasing use of plastics in different commercial applications they make up a fundamental part of our everyday lives. The degradation rate of plastic waste is also a very slow process. The project utilized following materials; overalls, gloves, masks, covered shoes or boots, 1 melting barrel (an oil drum cut in half, 80cm wide and 50cm high). If possible use a shield to keep the fire concentrated under the barrel. Stirring equipment (a spade with a metal shaft, or metal reinforcing rods with a metal paddle welded to the end). Firewood or other solid fuel, Clean, dry, sieved sharp sand, Tile mould (no more than 4cm deep), Used engine oil and Trowel. Hence project is helpful in reducing plastic waste in useful way. Sample of 300mm x 300mm x 15mm size sample are prepared. To evaluate different physical, chemical and mechanical properties, tests like water absorption, compression test, flexural test and flash and fire point tests are carried out as per IS specifications on plastic tiles and this tests were compared with the porcelain tiles, vitrified tiles and paver block. The results obtained have shown better results as compared to other tiles. These tiles can be better alternative to the ceramic tiles and other traditional tiles.*

Keywords: *Plastic waste, plastic tiles, tiles properties and waste management.*

R*eceived 04 Jan., 2023;* ***R****evised 14 Jan., 2023;* ***A****ccepted 16 Jan., 2023* © *The author(s) 2023.*
P*ublished with open access at* ***www.questjournals.org***

I. INTRODUCTION

Plastics due to their versatile nature are being widely employed in human lives. With the increasing use of plastics in different commercial applications they make up a fundamental part of our everyday lives [1]. Different types of plastics which are widely used are thermoplastics and thermo-setting plastics. Among these, thermoplastics can be easily and cheaply molded and re-molded to different usable forms [2]. Its plastic components contain several toxic substances [3]. Although these substances are not at levels to cause immediate risk, if quantities increase and end-of-life management is inadequate, such as the open burning often practiced in developing countries, there is potential for environmental pollution and human health impacts.

Recycling of waste is the best strategy for solid waste management, 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. Recycling of plastics is one method by which one can reduce its negative impact on the environment and prevent depletion of resources and can therefore decrease energy and material usage per unit of output and so yield improved eco-efficiency {4].

Production of plastic has leveled off in recent years, however, it is not declining and may well increase in the future as applications for plastic increase and its use continues to grow in developing and emerging economies [5]. Without appropriate waste management, this will lead to increased plastic waste, which will add to the 'back log' of plastic waste already in existence. There is no agreed figure on the time that plastic takes to degrade, but it could be hundreds or thousands of years [6].

In recent years researchers have focused their attention on finding suitable methods for recycling and re-utilization of plastic waste material in an economically and environmentally viable [7]. The main focus of this research work is to manage the problem of plastic waste through recycling in a comparatively less capital intensive manner.

Statement of theProblem

Abuja Municipal Area Council is facing a serious challenge in disposing plastics waste in many landfills throughout the city. The landfills situation is resulting in high disposal cost and potential environmental problems. Unfortunately, the properties of plastic that make it so valuable also make its disposal problematic, such as its durability, light weight and low cost. In many cases plastics are thrown away after one use, especially packaging and sheeting, but because they are durable, they persist in the environment. If plastic reaches the sea, its low density means it tends to remain on the surface. Several market-based instruments have been explored such as deposit schemes to encourage the return and multi-use of plastics, and taxation on single-use plastics that do not fit into deposit return systems. However there has been little widespread application of these instruments and more research is needed to maximize their effectiveness and ensure they do not have secondary effects other than those intended.

Plastic waste has the additional complication of spanning many policy areas, such as marine management, coastal management, waste management and the regulation of chemicals. This range of responses is necessary for such a global problem with such local variation, but to ensure plastic waste does not fall through the holes in the net of responsibility, there is a need to harmonize efforts and co-ordinate between different policy areas.

Justification

Processing technology should be ecological, more efficient and cost effective. Decentralized composting with the public and NGO should be encouraged. The organic waste should be returned to the farm in the form of manure. Recyclable waste should be returned to the recycle industry. In fact, scientists, technologists, environmentalists, and engineers all over the world are researching and developing effective disposal and utilization of plastic waste, for example, in the construction of infrastructure projects. Some of the recent developments are turning plastic waste into eco-friendly products and materials. The technologies like incineration and other should be avoided as their worth in our country has not yet been proven [8]. Proper disposal rules should be followed at the landfill sites[9].

In the pursuit of greener and cleaner environment to be achieved, we will need some very stringent steps to be taken. The time has come for all the stakeholders to come together for a common goal and to build a great nation for our coming generations. Let's come together hold the hands and march towards a more sustainable environment. As demand for materials with certain qualities increases, the plastics industry will aim to supply them. Meanwhile, increasing plastic production and use in emerging economies looks set to continue, and waste management infrastructure will have to develop accordingly.

Aim and Objectives

Aim: The aim of this work is to make a product of plastic tile from plastic waste.

Objectives are:

I. To classify locations of sorting stations for plastic waste in the study area
II. To determine the suitability of plastic waste in the development of plastic tiles for construction
III. To assess the effectiveness of plastic waste materials on the physical, mechanical and chemical characteristics of plastic tiles

II. STUDY AREA

Location

Abuja Municipal Area Council (AMAC) in Federal Capital Territory (FCT) is located at latitude 9.23^0 N and 9.36^0 N of the Equator and longitudes 6.74^0 E and 7.62^0 E and average Elevation of 537m (Figure 1). The FCT population is 1,402,201 (2006 population census) the (FCT) has a land area of 923,768 square kilometres (Km^2), which is more than two and halftimes Lagos state land mass area. The Federal Capital Territory shared boundary with Kaduna State, Niger State, Plateau State, and Kogi State.

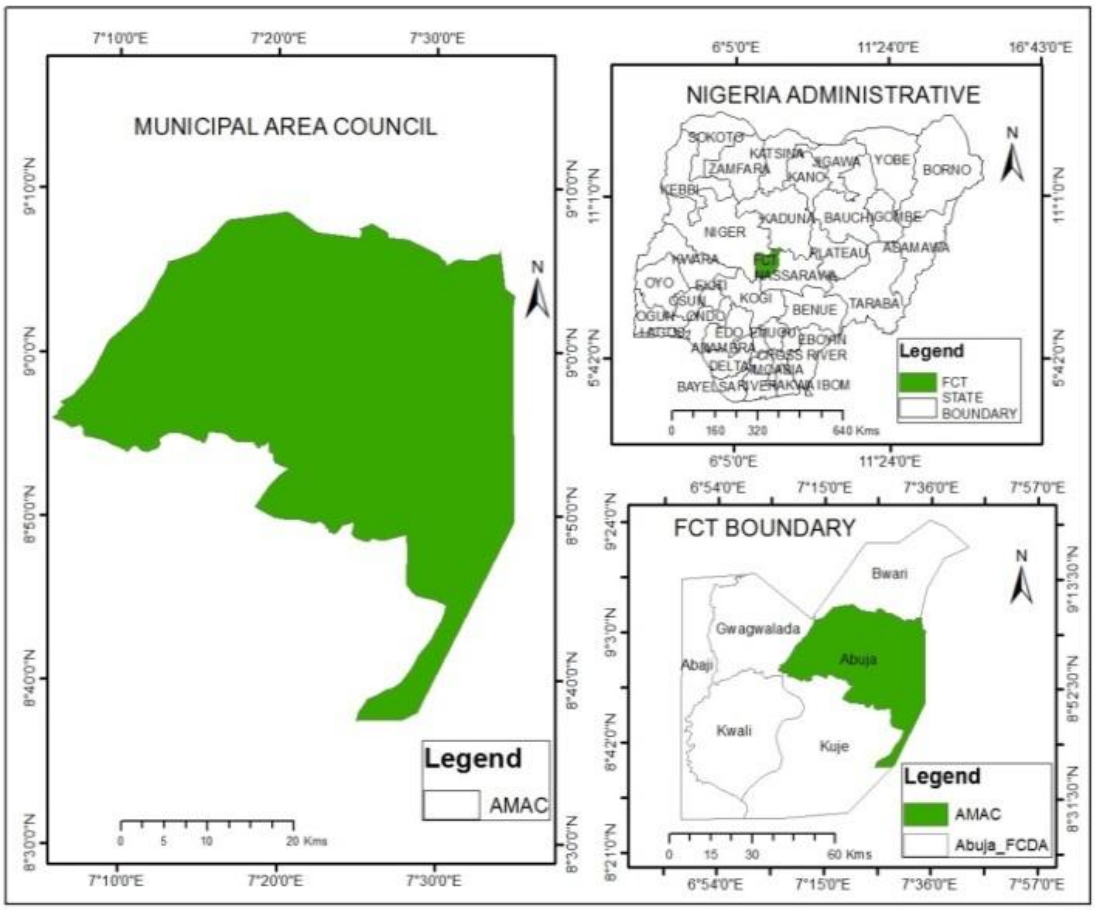

Figure 1 Study Area Map

Climate of Study Area

The Abuja municipal Area Council (AMAC), experiences two climate seasons, wet and dry season with a brief of Harmattan, occasioned by the movement of the northeast trade wind, with the features of dust and haze, which intensified coldness, and dryness. Rainfall in the AMAC starts by March and end in October. Humidity in raining season is high and also temperature around this time is moderate. The dry season stars from November and end in April, humidity in this period is very low and the temperature is high due to free cloud cover. The soil in Abuja Municipal Area Council is good for agriculture as it good for cash crop.

III. METHODOLOGY

Material

Overalls, gloves, masks, covered shoes or boots
1 melting barrel (an oil drum cut in half, 80cm wide and 50cm high). If possible use a shield to keep the fire concentrated under the barrel
Stirring equipment (a spade with a metal shaft, or metal reinforcing rods with a metal paddle welded to the end)
Firewood or other solid fuel
Clean, dry, sieved sharp sand
Tile mould (no more than 4cm deep)
Used engine oil
Trowel
Hint: Use fine, dry sand. The best type is 'sharp sand' or 'construction sand' used for making concrete. Sieve the sand to remove small and large particles that can lead to pockets of air, or pores, in the finished tile.

Method

Melting of plastic waste

The selected plastic waste is crushed into smaller particles and then melted in a container at a temperature of a melting point of 150 to 170^{0}C.

Mixing of materials

After the waste plastic is melted, the sand is added during heating and mixture is stirred continuously. The sand shall be added little by little in quantities and stirred well so that homogeneous mixture is obtained.

Placing of mixture (plastic + sand) in a moulds

Once the homogenous mixture of waste plastic in melted form and sand is formed, the mixture is fed into mould. The moulds are coated with oil for easy demoulding.

Demoulding

Once the mould is completely prepared, the mould is cooled either by air cooling or placing in the water. After the mould is cooled, the tile is removed from the mould. The plastic tile is ready for use.

Experimentation

For checking the properties of plastic tiles following test were done on the component.

Water Absorption Test (IS 10545-3:1995 Part-3)

The test specimen was completely immersed in water for 24 hours. Then the specimen is taken out the water and allowed then to drain for 1 minute. Then the specimen were wiped off and weighted immediately and weight of eachspecimen is noted. This can be represented as then these specimens were dried in a ventilated oven at 0 C for 24 hours. The dry weight of each specimen was recorded and of it is represented by Water absorption ٪ = [(W2-W1)] / [W1] x 100

Where,

W1 = weight of dry tile

W2 = weight of wet tiles

Compression Test

The specimen shall comprise of compression testing machine which shall be equipped with two steel bearings blocks for holding the specimen. The specimen on top through which load is transmitted shall be spherically seated and the block below on which the specimen is shall be rigidly fitted when the bearing area of the steel blocks is not sufficient to cover the bearing area of the specimen to steel bearing plates meeting the requirement.

Compressive strength of tile = max compressive load / min c/s area

Flexural Test

The load shall be applied from the top of the specimen in the form of simple beam loading through a roller spaced midway between the supporting roller. the load shall be applied without shock and increased continuously at a uniform rate of 6 KN/minute. the load shall be increased until the specimen fails and the maximum load applied shall be recorded.

Thickness of the plastic tile is, t = 15mm

Thickness of the porcelain tile and Vitrified tile is, t = 6mm

The flexural strength of the specimen shall be calculated as follows,Flexural strength, $Fb = M/I=\sigma b/y=E/R$

$\sigma b=(M.y)/I$

$Z = I/y$

$\sigma b=M/Z$

Where,

Fb = Flexural strength, in N/mm^2

M=mass=30Kg

l= moment of inertia mm3.

b = width of the tile in mm.

σ= bending stress in N/mm2

y=distance of extreme layer of section from natural axis in mm.

L= Center to center distance between two support.

Chemical Properties

Resistance to Chemical Reagents: This test was carried out according to ASTM D543. In this thesis, the various recycled plastics were immersed in hydrochloric acid with concentration of 5%, 15% and 60% concentration of the acid. These plastics were also immersed in sodium hydroxide with concentrations of 5%, 15% and 60% respectively. However, the recycled waste plastics were also immersed in a common salt called

sodium chloride. After 24 hours, the specimens were removed and evaluated for desired properties such as change in weight, appearance.

IV. RESULT AND DISCUSION

Results

Sorting stations

Figure 2 shows the sorting station in the Abuja Municipal Area Council (AMAC). The site should be in use and a place where citizens are accustomed to dispose their waste, hence a communal site. Sorting stations require an area of minimum of 260 m^2[10] there should be room for a minimum of two containers and a place for sorting.Whether the site is staffed or not the overall impression and other activities at the site do not determine whether the site is suitable for a sorting station. This information can also change in a short period of time.

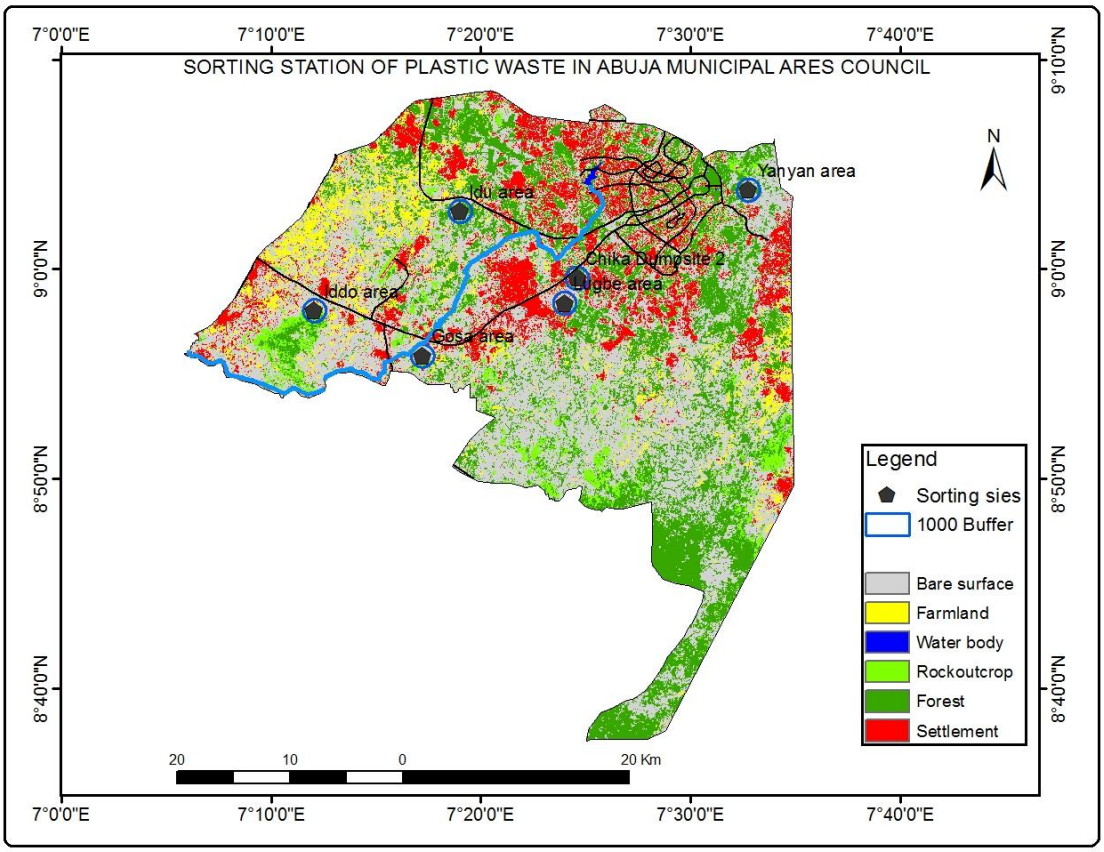

Figure 2 Waste plastic sorting station in AMAC

Plastic tiles

The color of the plastic tile depends upon the chemical and mineral constituents. Lime colours in the Plastic waste gives tan and light colors whereas brownish color is imparted by the presence of iron content. A dark grey to black color is typically attributed to an elevated un-burned content. Plates 1, 2 and 3 shows different colour of plastic tiles but the same properties

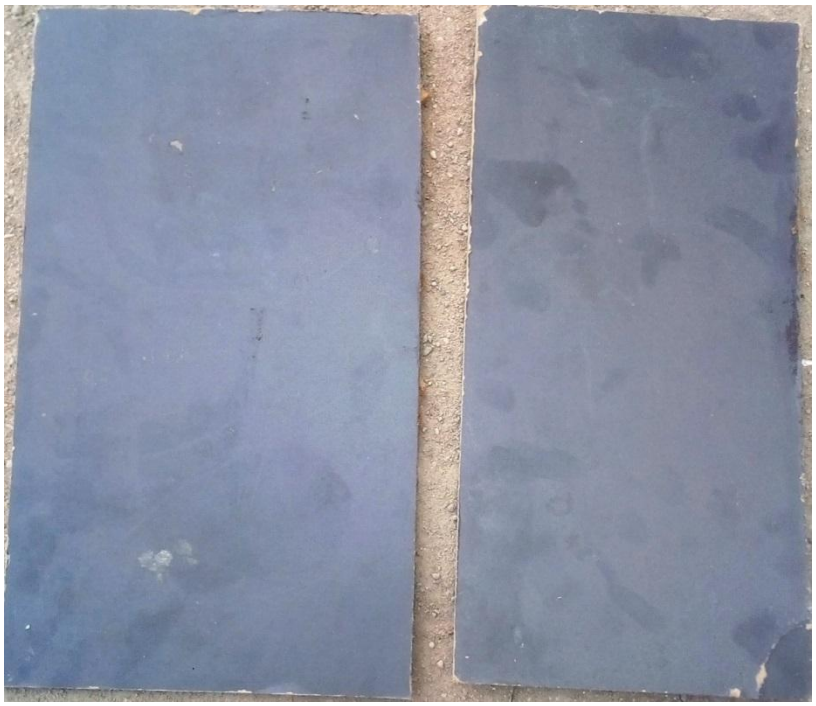

Plate 1: Plastic tile made of blue colour plastic waste

Plate 2: Plastic tile made from light colour plastic waste

Plate 3: Plastic Tile with customized stone

Table1 Water Absorption Test.

S/N	Description Of Specimen	Area mm2	Dry Weight Of Specimen (W1)	Wet Weight Of Specimen(W2)	Water Absorption
1	Plastic Tile	300X300	1426	1459	0.022
2	Ceramic tile	75800	6570	6778	3.16

From the result of Table 1 showed that ceramic tile absorb water than plastic tile. So, when looking for tile with high rate of water absorption is not plastic tile.

Table2.CompressionTest.

S/N	Description Of Specimen	Cross Sectional Area In mm^3	Compressive Load In KN	Compressive Strength In Mpa
1	Plastic Tile	300X300	900-950	10.56
2	Ceramic tile	75800	6570	9.2

From the result of Table 2 showed that plastic tile has compressive strengthen of 10.56 N/mm². and ceramic tile was 9.2. Therefore, plastic tile had more strength than ceramic tile.

Table 3 Flexural Test

S/N	Description Of Specimen	Mass (M) (Kg)	Moment (M) (N.mm) M=[(M×9.81) ×L]/4	Z=I/Y (Mm^3)
1	Plastic Tile	30	11.036×10	12250
2	Ceramic tile	-	-	-

Table 3 shows flexural strength of plastic tile is 0.98Mpa and plastic tile is not break

Chemical test result

The chemical resistance tests were performed on all tile specimens with the variations in cement tile and plastic composition. The results showed that the range of weight loss was from 0.3% to 0.52% with different material proportions used and developed tiles after experiments are shown inTable 4. During experimental practice, it was observed that increasing in percentage of cement tile leads in increased the weight loss of the tiles. The prepared tiles having cement and plastic without eggshells showed minimum weight loss and thereby more resistant against chemical attack.

Table 4 Resistance of Plastic tile at different percentage of Chemical

S/N	Plastic type	Hydrochloric acid (HCl) with concentrations			Sodium hydroxide (NaOH)			Sodium chloride (NaCL)
		5%	15%	60%	5%	15%	60%	
	Plastic bottles	E	E	G	E	EE		E

Where; E stands for excellent and it means the plastic tile is totally resisted for a particular substance at 5 to 15 percent chemical and G stands for good, which means that, the influence of that substance for a longer period of time causes little or no defects to the plastic tile.

IV. Discussion

You can make a variety of building materials that are cheaper than the concrete version. They set quickly and are very strong. Depending on the mould, you can make floor or paving tiles or even bricks for walls. They also make good rainwater harvesters: being non-water absorbent, the risk of dew, algae and fungus is almost eliminated, and this ensures clean water. You can add colorants such as iron to make red tiles. Bricks made with this technique make good insulation, keeping you warm in winter and cool in summer.

The sand in the tiles acts as a fire retardant. When there is a fire, the outer layer of plastic melts, leaving a face of sand. Sand is not flammable, so it slows the spread of the fire through the brick. Never light a fire directly on top of plastic floor tiles. Plastic tiles are not advisable for roofing in case of fire. They can be used to build structure which will be light weight, resistant to corrosion, chemically resistant, low cost of production, increased service life and most importantly put into use what is the menace for society-

The floor tiles are needed to be stand against the transverse loads so it is tested under CT according to provisions. For a normal tile transverse strength is 10.56 N/mm², as per results we got.

V. Conclusion

Plastic tiles made in this way are stronger than concrete tiles. If you can have your product tested and certified as an approved construction product, you will be able to market it to local building companies as well as directly to customers. Reduction in plastic waste it saves our environment and also reducing the amount of plastic. Waste plastic is generated by consumer and industry. It also reduces greenhouse gas emission and helps for prevent global climate change. The plastic tiles are more durable than traditional tiles with respect to various perspectives as written in result.

REFERENCES

[1]. Ahluwalia, I. J., Munjee, N., Mor, N., Vijayanunni, M., Mankad, S., Lall, R., & Others. (2011). Report on Indian urban infrastructure and services. World, 284.

[2]. Akçaözoğlu et al., (2010). Recycling of plastic waste into tiles with reduced flammability and improved tensile strength. Process Safety and Environmental Protection Volume 124, April 2019, Pages 299-307

[3]. Andrady and Neal, (2019). Applications and Societal Benefits of Plastics August 2009Philosophical Transactions of The Royal Society B Biological Sciences 364(1526):1977-84 DOI: 10.1098/rstb.2008.0304

[4]. Butler E, Devlin G, McDonnell K (2011) Waste polyolefins to liquid fuels via pyrolysis: review of commercial state-of-the-art and recent laboratory research. Waste Biomass Valori 2(3):227–255

[5]. Global Industry Analysts (2011) Molded Plastics: A Global Strategic Business Report. Global Industry Analysts Inc.

[6]. Hamad et al., (2013). Eco-Efficiency of Construction Materials: Data Envelopment Analysis June 2012 Journal of Construction Engineering and Management 138(6):733-741 DOI: 10.1061/(ASCE)CO.1943- 7862.0000484

[7]. Kershaw, P., Katsuhiko, S., Lee, S. et al. (2011) Plastic Debris in the Ocean in UNEP Year Book 2011: Emerging issues in our global environment, United Nations Environment Programme, Nairobi.

[8]. Material, C. (2010). Training on solid waste management. Centre for Environment and Development, (May).

[9]. Nnorom, I.C. &Osibanjo, O. (2009) Toxicity characterization of waste mobile phone plastics. Journal of Hazardous Materials. 161:183-188.

[10]. UN-HABITAT (2010). Solid waste management in the world's cities, water and sanitation in the world's cities.Earthscan.