ASSESSMENT OF PLASTIC WASTE RECYCLING METHODS FOR A SUSTAINABLE DEVELOPMENT IN MINNA,

NIGER STATE, NIGERIA

BY

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DECLARATION

I, Aderoju, Olaide Monsor, with registration number M.Tech/SSSE/2006/1490, hereby declare that this thesis is entirely my original work and personal academic exercise and has not been presented elsewhere either in part or in full for any post-graduate degree at any university or any institution of higher learning.

16/03/2009

Aderoju Olaide Monsor

Date

DEDICATION

This project is dedicated to God for protecting and blessing me throughout my course of study in Minna. Also to my late father Mr. B.L Aderoju, and my late friend and colleague Kingsley.

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ABSTRACT

This study has shown that the non-biodegradable nature of plastics have made them to constitute a serious nuisance to the environment, which leads to other environmental issues. The problem of plastic wastes is very acute in the Niger State capital, Minna, due to the fact that the culture, population and capacity to handle plastic wastes is lacking. Various methods of waste disposal have been used but most of these disposal methods leave an adverse effect on the environment. This study adopted an approach from the Integrated Waste Management (IMW), which is the 3R's (Reduce, Recycle, Reuse) method. This 3R's method is the best and most reasonable method of waste management whereby jobs are created, energy is saved, cost is reduced, and it cleans the environment without adverse effects. Based on the analysis of the physical survey, it was deduced that there exist 32 major and 108 minor dumpsites in Minna metropolis, it was also deduced that Sokakahuta and Mobil/Katerigwari/Kwangila/Sabon Gari in Minna metropolis have the highest number of major dumpsites, while Eastern bypass and Airport Road/123 quarters have the lowest number of dumpsites in Minna metropolis. The respondents to research questionnaires at different localities revealed that they have different perspectives about waste based on the locality and level of awareness. It was also revealed by the respondents to questionnaires that all types of waste disposal methods are mostly practiced, except the 3R's strategy, which involves the recycling of plastic wastes. This 3R's strategy goes by reducing sources of generations from residential homes, offices, market places, etc, wastes are then sorted out to pick out plastic wastes and dumpsites are also visited to pick out plastic wastes by scavengers, all to be sold to material recovery firms. These material recovery firms sell the plastic wastes to plastic recycling industries. This study proved that when plastic wastes are recycled, 70% are recovered as raw materials for the production of new products. This test was carried out at the Usmani Pipes and Plastics Limited. It was found that 20% of the cost of production was saved without considering the entire cost of production of those manufactured from the ore form during comparison. The 3R's (Reduce, Recycle, Reuse) as a strategy, should be encouraged because recycling is big business.

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CHAPTER ONE

INTRODUCTION

1.1 Historical Background

Waste can be defined as that which is cheaper to throw away than to utilise (Henstock 1983). It does not mean that waste is totally valueless. A discard can be a waste depending on the price of new raw materials, if these were to become much more expensive relative to the cost of transporting and processing a waste material that might serve the same purpose it would presumably become worthwhile to utilize the latter. A proper management of waste can be achieved if taken seriously.

Waste management is an important objective of planning to ensure that the future generations inherit an environment that is as pollution free as possible given present scientific, economic, social and political constraints. Waste management is the collection, transport, processing, recycling or disposal of waste materials usually produced by human activities in an effort to reduce their effect on human health or local aesthetics or amenity. A subfocus in recent decades has been to reduce waste material effects on the natural world and environment and again recover resources from them. Waste can be in solid liquid or gaseous form and it has different methods and field of expertise for its effective management (US Environmental protection agency report, 2005).

Municipal solid waste (MSW) are commonly known as trash or garbage that consist of everyday items such as product packing, grassing, clipping, furniture, clothing, bottles, food scraps, metal carp, newspaper and most of all plastics and many more. In 2005, United States residents, businesses and institutions produced more than 245 million tons of municipal sold waste, which is approximately 4.5 pounds of waste per capita per day (Cunningham and Saigo, 1997).

The environmental preferable concept with respect to waste management is considered as resources out of place (Botkin and Keller, 2003). Under this concept, waste would not exist because it will not be produced, or if produced, it would be a resource to be used again. The process of getting waste reused again is referred to as recycling. Nowadays wealth is being generated form waste through the process of recycling and reuse of this product. This is mostly done in developed countries and some other developing countries. In most developing countries, these strategies of recycling process is yet to be adopted, and more so environmental problems erupt everywhere likewise acute and chronic diseases too (Cunningham and Saigo, 1997). Although we may not soon be able to reuse and recycle all waste, it seems apparent that the increasing cost of raw materials, energy, transportation and land will make it financially feasible to reuse and recycle more resources. Thus it simply means moving towards this objective is the same as moving towards an utopian environmental view that there really is no such thing as waste, only resources (Botkin and Keller, 2003).

In recent times, where solid wastes like plastics, paper, metal scraps and many more have been discovered as resources that can be reused or recycled into the earlier product and the kinds of related products. It is rather reasonable to embark on recycling process so that our material resources will not go into extinction (US Environmental protection agency report, 1995).

1.2 Statement of the Project

Apart from the fact that there is a saying that "health is wealth" we can also generate wealth from waste too. Waste like leaves, paper food items and many more that can degrade without causing any adverse effect on the environment. Biodegradable wastes like leaves and food items with the concept of integrated waste management (IMW) using 3R (Reduce, Recycle, Reuse) to convert these biodegradable waste to humus soil through compositing. Thus, the resultant product humus soil can be reused as manure for planting of shrubs.

Unlike plastics that are non-biodegradable which cause a great nuisance in the environment.

The most common kind of plastic waste are nylon carrier bags, pure water sachet, plastic bottles etc. the nylon are aided by wind and blown across fields, fence wires and into drainage systems which results into blockages of drains which is the root of some other environmental problems like flood and it is a breeding ground for pathogenic diseases.

The problem of plastic waste in the environment has really raised eye brows and it needs to be dealt with before it gets worse

1.3 Aim and Objectives

1.3.1 Aim

The broad aim of this thesis is to seek an approach of the 3R's (Reduce, Recycle and Reuse) to manage waste plastics in Minna for a better economic and environmental growth.

1.3.2 Objectives

i. To examine and identify the sources of generation and the dump sites in Minna.

ii. To assess the attitude and practices of the populace towards the pattern of refuse disposal.

iii. To come up with concept and strategies to use 3Rs strategy on waste plastics and assessing the rate at which strategy will be of economic value and environmentally sustainable.

iv. To come up with recommendations and suggestion on how to improve on this strategy for a greater development

1.4 Study Area

Minna is a city in north central Nigeria; it is the capital of Niger State. It is located on latitudes $9^{o}33'N$ and $9^{o}45'N$ also on longitude $6^{o}34'E$ and $6^{o}42'E$. The geographical formations present in Minna basement complex and sedimentary rocks.

The population of Minna is denser compared to other parts of Niger state. Minna like the rest of the sub region experiences a distinct wet and dry season with

annual rainfall varying from 1100mm to 1600mm. the rain season starts from the month of April to October with peak in June and July or august and September in some years (Uthande, 2001).

The mean maximum temperature in Minna does not exceed 18°C and it is usually between the months of March and June before the onset of the rain. The temperatures are minimal during the months of December and January (Academy press official diary, 1996).

Minna experiences very violent line squalls during the onset of the rainy season. Also dust devil usually occurs at the end of the rainy season and the beginning of dry season (Uthande, 2001). In terms of vegetation, Minna belongs to the Guinea savannah region. The region is characterised by tall grasses with scattered trees like locust beans, shear butter, mango etc. The reality is quite different because due to massive deforestation for fuel wood shifting cultivation in the region has lead to the creeping of the Sudan savannah into Guinea savannah with its characteristics of short grasses and trees with twisted trunk which are however very scanty (Uthande, 2001). The soil type in Minna is generally loamy sand, which is well drained and has a high water infiltration rate (Academy press official diary, 1996).

Cotton, guinea corn, yam and ginger are the main agricultural products of the town. The economy also supports cattle trading, brewing, shear nut processing and gold mining. Traditional industries and craft in Minna include leather works, metal

working and cloth weaving. Minna is connected to both Kano in the north and Ibadan and Lagos in the south by rail and road. The city also has a small airport.

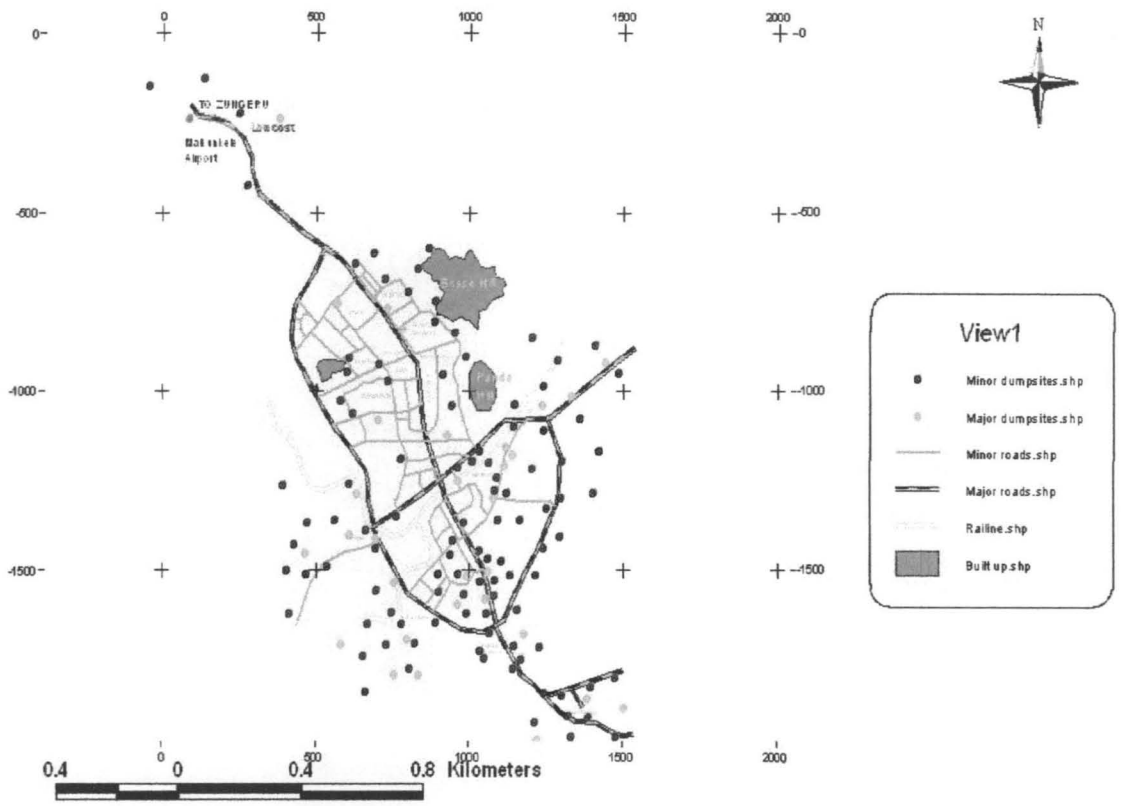

Fig 1.1 **MAP OF MINNA METROPOLIS SHOWING DUMPSITES**

1.5 Scope of Study

This has been limited to the use of 3Rs strategy (Reduce, Recycle and Reuse) for assessing plastic waste in Minna, Niger State.

1.6 Justification of the Study

This study is of great importance to every individual because of the increased waste plastics generation. In the north generally, the ideology of using plastics (nylon) for packaging is widely used and this packaging material is usually called "leather". Several policies and series of programs like environmental sanitation have been made on how to keep our environment but never had the privilege to implement it or cared less about it.

In Minna municipal, the most common type of waste in residence, market places, government organisations, eateries, institutions etc are plastic waste. These plastics waste litters every where in the town constituting a great nuisance on the street and so are even blown into drains by the inhabitants of the town leading to drainage blockage and other environmental pollution problems. The common type of disposal system for refuse or trash in Minna is the open dumps and landfill dumping which has plastic waste as the most predominant. This is due to the fact that most packaging done is usually done with plastic materials (nylon). This plastics waste issue in Minna is really a problem because plastics are non biodegradable and can be in the environment for several years.

The concept of the 3Rs (Reduce, Recycle and Reuse) will help clean up the environment, create jobs for the unemployed and it could be a source of revenue for the state government if it plays a major role in implementing the strategy. The use of the 3Rs concept in the managing plastics waste in any environment is a positive move for sustainable development of any city.

CHAPTER TWO

LITERATURE REVIEW

From the earlier civilization, the disposal of waste has always been a problem that requires special attention. With skyrocketing human population and the complex nature and larger volume of solid waste, the problem of waste management has become magnified (Uthande, 2001).

Municipal waste that is alternatively known as "urban waste" is used to designate all types of waste likely to be collected and delivered to a public or private disposal site such as a dump, landfill or incinerator (Henstock, 1983). Solid waste generally is organic or inorganic and it can also be biodegradable and non-biodegradable. The persistence of huge urban refuse is one of the most chronic headaches of municipal administrations in Nigeria (Uthande, 2001).

2.1 Recycling

The term recycling is the process of collecting materials that are often considered trash, reprocessing them into new products that can be resold or reused again. This option is applicable to all types of waste and the concept is that waste should not be thrown away but should be processed to return it to the society as useful product. As a general rule, little process or treatment is required to prepare the waste materials for its intended use. Examples are the reuse of plastics, glass bottles, and tin containers from refuse dumps for domestic use. Thus the term recycling has two meanings in common usage. Sometimes we say we are

recycling when we are reusing something such as refillable beverage containers. In terms of solid waste management, however is the reprocessing of discarded materials for the same purpose, for example waste plastic pipes melted and reproduced as new plastics. Other recycling processes turn old materials into entirely new products.

In a situation where waste material is subjected to specific treatment process in order to derive a useful end product(s) to be utilized for a different purpose, the practise is referred to as recovery form waste. Recycling reduces energy consumption and air pollution. Plastics bottle recycling could save 50% to 60% of the energy needed to produce new ones. Right now, china's second richest billionaire is a woman who makes her money from recycling. She buys scrap from the United States and recycles it and sells it (Holmes K, 2007).

Generally recycling turns materials that would otherwise become waste into valuable resources. In addition it generates a host of financial and social benefits.

2.2 Type of Recycling Process

Recycling can be done internally (within a company) or externally (after a product sold is used).

2.2.1 Internal Recycling

This occurs when leftover materials stock and trimmings are salvage to help make more new product. Since the recovered material never left the manufacturing plant, the final product is said to contain pre consumer waste.

2.2.2 External Recycling

This occurs when materials used by customers are returned for processing into new products. Materials ready to be recycled in this manner, such as empty plastic containers are called post consumer waste.

2.3 Benefit of Recycling

i. Recycling Reduces Waste; Recycling reduces the volume of waste going to the landfills. Large cities may face, problems as current landfill reach capacity.

ii. Recycling Reduces Pollution; The manufacture of materials from ore often generates pollution of the air (smoke stuck emissions), water and land.

iii. Recycling Saves Resources; A principal reason to recycle waste is to reduce the need to mine, quarry, or log the original resources, this extending the life of the resources base.

iv. Recycling Protects Land; This is because we eliminate the need to alter the landscape by mining or quarrying. Furthermore, the reduction in waste results in less land being converted to landfills.

v. Recycling Saves Energy; The energy require for recycling is less compared to the one used to manufacture it from ore form. By saving energy, recycling also reduces pollution, reduce cost and resources.

vi. Recycling Is Good for Business; For example, plastic recycling, paper recycling, metal scrap recycling yields profit.

vii. Recycling procedures helps to create employment amongst the citizens.

2.4 Plastics

According to Richardson (2006), plastics are materials made up of large, organic (carbon containing) molecules that can be formed into a variety of products. Plastic materials are made up of long, chainlike molecules called polymers. The word plastic is derived from the plasticus (latin for "capable of moulding") and plastikos (Greek "to moulding").

Plastics are also light weight, water proof, chemical resistant and produced in almost any colour. There are more than 50 families of plastics that have been produced, and new types are currently under development.

2.4.1 General Properties of Plastics

Plastic possess a wide variety of useful properties and are relatively inexpensive to produce. They are lighter than any material of comparable strength and plastics are non-biodegradable. Most plastics can be produced in any colour. They can also be manufactured as clear as glass, translucent (transmitting small amount of light) or opaque (impenetrable to light).

Plastics have a low density that varies from 0.9 to 2.2g/cm^3 (Richardson, 2006). Plastic can be reinforced with glass and other fibre to form incredibly strong material. Plastics when burnt, some plastics produce poisonous fumes.

Although certain plastics are specifically designed to withstand temperature as high as 288°C. In general plastics are not used when high heat resistance is needed because of their molecular stability, and plastics do not easily breakdown into

simpler components. As a result disposal of plastics create serious environmental problems.

2.4.2 Thermoplastics and Thermosetting Plastics

All plastics, whether made by addition or condensation polymerisation can be divided into two groups; thermoplastics and thermosetting plastics. These terms refer to the different ways these types of plastics respond to heat. Thermoplastics can be repeatedly soften by heating and hardened by cooling. Thermosetting plastics, on the other hand, harden permanently after being heated once. The reason for the difference in response to heat between thermoplastics and thermosetting plastics lies in the chemical structure of the plastics (Richardson, 2006).

Thermoplastics can be heated and cooled, and consequently softened and hardened, repeatedly, like candle wave. For this reason, thermoplastics can be remoulded and reused almost indefinitely.

2.5 Types of Plastics

A wide variety of both thermoplastics and thermosetting plastics are manufactured. These plastics have a spectrum of properties that are derived from their chemical composition. As a result, manufactured plastics can be used in applications ranging form contact lenses to get body components.

i. Polyethylene (PE) resin are milky white, translucent substance derived from ethylene ($CH_2=CH_2$). Polythene, with the chemical formulae ($-CH_2-CH_2)n$ (where n denotes that the chemical formulae inside the brackets

repeats itself to from the plastic mode is made in low and high density forms).

ii. High Density Polyethylene (HDPE) high molecular (HM) this is mainly used for the manufacturing of drums and containers, to hold liquids such as oil, chemicals and food additives and move. This plastics itself is also fully recyclable, but this can only take place once nocuous or hazardous substance has been removed.

iii. Medium Density Polyethylene (MDPE): This is a very popular material with range of uses. The material is extensively used in extrusion grade for the manufacture of plastic glass and water pipes. It is also in its rotomold form in the production of wheelie bins and large storage tanks for fuel and oil in both domestic and commercial field.

iv. Low Density Polyethylene (LDPE): This material is used both domestically and commercially. It is fully recyclable. Popular applications include polyethylene bags (bins liners, sandwich bags, carrier bags, etc.) are widely used in the manufacture of food containers, with special grades being developed for flexible resealable lids.

v. Linear Low Density Polyethylene (LLDPE): The main applications for this materials extrusion grade; for the manufacture of cling film and shrink wrap in packaging industry this product is fully recyclable but if contaminated with other materials, can often be an issue when recycling.

vi. Polyvinyl Chloride (PVC): this is prepared form the organic compound vinyl chloride (CH_2=CHCl). PVC is the most widely used of the amorphous plastics. Chlorine atoms bonded to the carbon backbone of its molecule gives PVC its hard and flame resistant properties. In its rigid form, PVC is weather resistant and is extruded into pipe, house siding and gutters.

vii. Polypropylene: This is polymerized from organic compound propylene (CH_3-CH=CH_2) and as a methyl group (-CH_3) branching off of every other carbon along the molecular backbone. Many polypropylene product; such as rope, fibre, luggage, carpet, and packaging film are formed by injecting moulding.

viii. Polyamide (PA): This is known by the trade name Nylon; consist of highly ordered molecules, which give polyamide high tensile strength. Some polyamide are made by reacting dicarboxyclic acid with diamines (carbon molecules with the ion –NH_2 on each end) as in nylon-6, 6 and nylon-6,10. The most commonly used nylon fibres, nylon-6, 6 and nylon-6 (single number because this nylon forms by the self-condensation of an amino acid) are made into textiles, ropes, fishing lines, bushes, and other item.

There are other types of thermoplastics like polystyrene, polyethylene terephthalate, acrylonitrile butadiene styrene, polynethyl, methacrylate. And for thermosetting materials which consist of polyurethane, phenolics, unsaturated polyester epoxy, reinforced plastics and many more.

2.6 Recycling Of Plastics

All plastics can be recycled. Thermoplastics can be melted and made into new products. Thermosetting plastics can be ground commingled (mixed) and then used as filler in mouldable thermoplastics materials. Highly filled and reinforced thermoplastics can be pulverized and used in new composite formulations.

Chemical recycling is a depolymerization process that uses heat and chemical to break plastics molecules down into more basic components, which can be reused. Another process called pyrolysis, vapourises and condenses both thermoplastics and thermosetting plastics into hydrocarbon liquids.

2.6.1 Recycling Process for Plastics

This process normally involves cleaning it, shredding it into flakes, and then melting the flakes into pallets. The pallets are melted into a final product. Some products work best with only a small percentage of recycled content. Other products, such as high density polyethylene (HDPE) plastics milk cases, can be made successfully with 100% recycled content.

2.6.2 Recycling Different Types of Plastics

Plastics are especially troublesome, as different types of plastics require different processing to be reformulated and reused as a raw material. Some municipals accept all types of plastics for recycling, while others only accept jugs, containers and bottles with certain numbers stamped on their bottoms.

2.6.3 Recycling By the Numbers

The society of plastic industry (SPI) in 1988 designed the symbol code we are familiar with a single digit ranging from 1-7 and surrounded by a triangle of arrows. This allows consumers and recyclers to differentiate types of plastics while providing uniform coding systems for manufacturers. According to the American plastic councils, an industry trade group, the symbols also help recyclers do their job more effectively.

i. Easy Plastics to Recycle: The easiest and most common plastics to recycle are made of polyethylene terephthalate (PETE) and are assigned as number 1. Examples include soda and water bottles, medicines containers, and many other common consumer product containers. Once it has been processed by recycling facility, PETE can become fibrefill for winter coats, sleeping bags and life jackets. It can also be used to make bean bags, rope, car bumpers, tennis ball felt, cassette tapes, sails for boats, other plastic bottles. Number 2 is reserved for high density polyethylene plastics. This includes heavier containers that hold laundry detergent and bleaches as well as milk, shampoo and motor oil. Plastics labelled with number 2 are often recycled into toys, piping, plastics lumber and rope. Plastics designated number 1, are widely accepted at recycling centres.

ii. Plastics Less Commonly Recycled: Polyvinyl chloride (PVC), commonly used as plastic pipes, shower curtains, medical tubing, vinyl dashboards, and even some baby bottle nipples, gets number 3. Like number 4

(wrapping films, used in Tupperware, among other products), few municipal recycling centre will accept it due to its very low rate of recyclables.

iii. Another Useful Plastic to Recycle: Number 6 goes on polystyrene (styrofoam) items such as coffee cups, disposable cutlery, meat trays, packing "peanuts" and insulation. It is widely accepted because it can be reprocessed into many items, including cassette tapes and rigid foam insulation.

iv. Hardest Plastic to Recycle: Number 7 is the hardest plastics to recycle. They are mixed plastics that are non-recyclable.

2.7 Waste Plastics as a Global Issue

Plastics have become an indispensable part of our daily life. But repeated reprocessing of plastic waste, and its disposal cause environmental problems, pose health hazards, in addition to public nuisance. The balance unutilized waste remains uncollected lying strewn on the ground, littered in open drains or in garbage dumps, often resulting in chock age of municipal sewers and storm water drains. It should be remembered that collection of plastic waste is a source of livelihood for innumerable "rag pickers", or waste collectors. Plastic waste collection is a lucrative business when compared with that of other items.

In India, a typical kabadiwals displays the following waste with its rates.

- Newspaper in English ---------- Rs 4 to 5 /kg
- Newspaper in Hindi ---------- Rs 3 to 4 /kg

- Magazine ---------- Rs 3 to 3 /kg
- Iron Scrap ---------- Rs 5 to 50 /kg
- Plastic Waste ---------- Rs 12 to 15/kg
- Bear Bottle ---------- Per bottle Rs 2

Yet plastics waste commands the highest rate of recycled market (The Hindi Newspaper, 2001).

The issue boils down to management of plastic waste for a sustainable development. The best strategy for effective management of plastic waste should three R's- reduction, reuse and recycle, and include a package of prevention, promotion and mitigation (Narayan, 2001).

In Agenda 21 of the United Nations conference in Rio in 1992, recycling has been assigned a position as important as conservation and saving energy. The more that is recycled, the longer will natural resources be available for future generations.

2.8 Using Pyrolysis for Plastic Waste Recycling

Presently the greatest environmental problem facing developing countries especially Nigeria is municipal and public waste management due to the present economic situation in Nigeria, water is packaged in (LDPE) satchet that serves as the cheapest packaging material. (Ademiluyi and Adebayo, 2004) were able to produce ethylene monomer from polyethylene waste through the process of Pyrolysis.

Again (Ademiluyi and Akpan, 2004) also produced fuel oil from waste polyethylene (pure water sachet) through the process of Pyrolysis. This fuel oil was found out that it is use by an America water jet as its fuel.

The disadvantages of all this research is that it will be capital intensive if we were to explore this jet fuel in large quantity it will be relatively expensive. During the process of Pyrolysis of polyethylene, some poisonous gases are produced and these gasses includes carbonmonoxide,carbondioxide,methane,ethane,brutane e.t.c. Some of these gases are major contributors to global warming.

Thus, this study will come up with a strategy that is relatively cheap for any sustainable development and contribute less towards the warming of the planet.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Data Collection Method and Analysis

Data collection for this research was done through survey work using questionnaire method and physical observation method. The data collected were analysed based on simple percentage method.

3.2 Data Collection Method

This research was carried out with the aid of questionnaire and physical survey of concerned sites. The respondents of this questionnaire were limited to residence of Minna metropolis, Alif maintenance, Niger state urban development board. There three method of administering questionnaires.

i. Personal interview with researcher reading from the prepared questions

ii. Self administered questionnaire, where the questionnaires are deposited with the respondent to be collected after filling. It can also be mailed. This gives the respondent enough time to fill the questionnaire but respondent rate could be very low.

iii. Other methods include telephone conversation.

3.3 Types of Questionnaire

i. Structured questionnaires are the ones which usually have a fixed alternatives or enclosed item responses to the limited answers provided.

ii. Unstructured questionnaire/schedule or interview guide which are open ended and allows respondents and interviewers to discuss freely with regards to the research problems.

Note: structured questionnaire was used for this research thesis.

3.4 Personal Survey

The dump sites both minor and major was visited in Minna, with evidence of pictures to show the extent of the amount of Plastic wastes like nylons, pure water sachets and other plastic wastes present at these dumpsites. The areas of these dumpsites was identified and noted. These dumpsites were also identified and classified based size and height.

With the aid of questionnaires, the attitude and practices of the populace towards

3.5 Methods

1. Sources of generation of waste were examined through questionnaires and dumpsites were identified through survey which was classified into two major groups based on sizes and height. Both the major and minor dumpsites are shown on the map of Minna metropolis, showing their locations.

2. Refuse disposal was assessed and analyzed through a simple percentage method. There were 300 questionnaires distributed but just 180 pieces were recovered.

3. The method used was the 3R's (Reduce, Recycle, Reuse), which is an approach of waste management. The steps are as follows:

   i. Scavengers and rag-pickers go to residents to collect refuse and sort out plastic wastes of various types like nylons, pure water sachets, plastic bottles, and other plastic products that can be recycled or reused. The scavengers wash these plastic wastes and sell to the material recovery firms.

   ii. The material recovery firms buy plastic wastes from scavengers on a standard price based on the weight of the plastic wastes. The material recovery firms sell to plastic industries and recycling industries at prices that are profitable.

   iii. Plastic industries and recycling industries buy plastic wastes as raw materials from the material recovery firms, then recycle them for the production of similar products or convert them to some other products within the family of plastics. Plastic wastes are recycled based on their quality and are therefore categorized into three grades.

   iv. When new products are being made from recycling of plastic wastes, they will be sold to consumers for their own use.

   v. A simple sketch shows the cycle of plastic wastes to wealth by using the 3R's (Reduce, Recycle, Reuse) strategy.

4. A simple test was conducted at Usmani Pipes and Plastics Limited, where we recycled plastic wastes of three different grades. The grades were based on the quality of the plastic wastes and each grade weighed 1kilogram. These plastic wastes serving as raw materials were recycled and it was made into new products. The prices of the recycled plastic products were compared to those manufactured from ore form.

3.6 Sketch of the Distribution Channel of the 3R's.

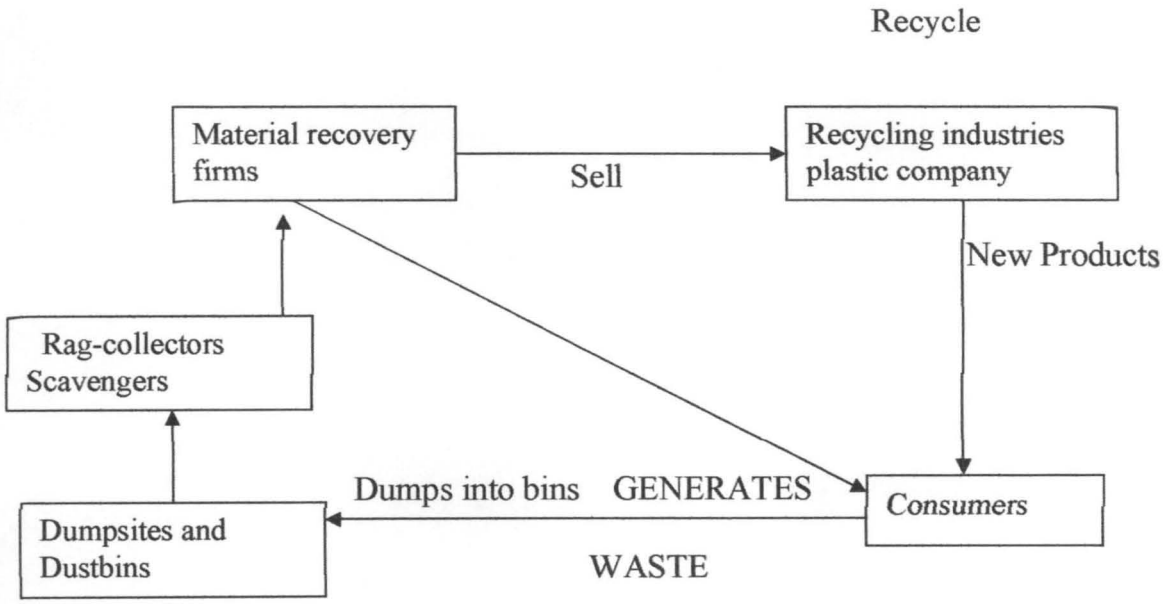

Fig 3.1 **Cycle of Plastic Waste from Waste to Wealth**

CHAPTER FOUR

RESULTS

This chapter presents the results and analysis obtained from physical surveys and questionnaires administrated to the residents of Minna. There were three hundred questionnaires given out, but only one hundred and eighty questionnaires were returned.

4.1 Analysis of Physical Survey to Dumpsites

The dumpsites are classified as major dumpsites if the size is more than 25 m^2 by area and height of 1m, but if less, it is a minor dumpsite.

Table 4.1 Location of Identified Dumpsites and Types

Location	Number of Major Dumpsites	Number of Minor Dumpsites
Bosso	**3**	**12**
Maitunbi	**3**	**9**
Okada road/Dutse Kura	**1**	**4**
Tunga	**3**	**11**
Sango/Gidan Madara	**1**	**7**
Chanchaga/Tungangoro	**4**	**10**
Sokakahuta	**5**	**10**
Kpakungun/Barikinsali	**4**	**12**
Maikunkele	**1**	**5**

Eastern by pass	**0**	**8**
Mobil/Kateri Gwari/Kwangila/SabonGari	**5**	**14**
Airport road/123 Quaters	**0**	**2**
Stadium road/Kuta road/Limawa	**2**	**4**
Total	**32**	**108**

Source: Author's Field Work

The researcher tried to cover the whole of the metropolis to have true representation of waste generation and disposal. It was noticed that more of nylons, plastic bottles and other plastics were the most predominant non-biodegradable present at these dumpsites.

The analysis of these dumpsites within Minna metropolis was represented on a map of Minna showing the true picture of refuse problem of which plastic waste are the most dominating.

4.2 Analysis of Result of Respondent to Questionnaires

The analysis of results of response from the questionnaires distributed was done by a simple percentage method. This simply entails the total number of 'yes' responses to a question, as to the total no of 'No' responses. It s on the basis of this result the analysis was made in percentage basis and results are presented in tabular form.

Table 4.2 Location of Respondent

Location	Number of response	Percentage of response (%)
Bosso	31	10.33
Sokakahuta	19	6.33
Sango/Gidan Madara	22	7.33
Chanchaga	21	7.00
Maitunbi	9	3.00
F-Layout/GRA	21	7.00
Tunga	20	6.66
Kpakungun/Barikinsali	18	6.00
Okada road/Dutse Kura	19	6.33
Total	**180**	**60**

Source: Author's field work.

Table 4.3 Table on the Type of Disposal Method

Types of Disposal	Figure	Percentage (%)
Private refuse Dumps	40	22.22
Public Dumps	90	50.00
Other means (Roadsides, Gutters etc.)	50	27.78

Source: Author's field work.

Due to lack of dustbins 50% of the respondent resort to the use of public dumpsites to dispose of their refuse, while 22.22% have their own private dump behind their homes. The remaining 27.78% dump theirs into gutters or roadsides dumps, as shown in the table 4.4 above. These last batches are the cause of blockage in the drainage systems.

Table 4.4 Table on who like to reside near a Dumpsite.

Response	Figure	Percentage (%)
Yes	0	0
No	180	100

Source: Author's field work

According to the response of the people, it was obvious that nobody likes to live near dumpsites. Everybody wants to live in a clean environment but less effort is made towards achieving it.

Table 4.5 Refuse Dumps initiates Diseases

Refuse	Figure	Percentage (%)
Yes	135	75
No	45	25

Source: Author's field work

Table 4.7, has shown that the percentage of the respondent, that there is a very close relationship between refuse dump being an initiator of disease is 75% while the other 25% of the respondent were ignorant of the relationship between refuse dump and disease.

Table 4.6 Separation of refuse in homes into Separate bins to promote Recycling

Response	Figure	Percentage (%)
Yes	30	16.67
No	115	63.89
Neutral	35	19.44

Source: Author's field work

Table 4.8, has shown that the percentage of the respondent who will prefer to use separate bins so that waste can easily be sorted for recycling 16.67% responded positively, 63.89% responded negatively while 19.44% were indifferent of the conditions.

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PLATE III **OKADA ROAD**

PLATE IV **OKADA ROAD**

PLATE V **MYPA**

PLATE VI **MYPA**

PLATE VII **F – LAYOUT**

PLATE VIII **MAITUMBI**

PLATE IX **MAITUMBI**

PLATE X **MAITUMBI**

PLATE XI MINOR DUMPSITE (SANGO)

PLATE XII **SANGO**

PLATE XIII **MAJOR DUMPSITE (GIDAN MADARA)**

PLATE XIV **SOKAKAHUTA**

PLATE XV **SOKAKAHUTA**

PLATE XVI **CHACHANGA**

PLATE XVII **MINOR DUMPSITE (TUGAN GORO)**

PLATE XVIII **CHACHANGA**

PLATE XIX **KPAKUNGUN**

PLATE XX **MAJOR DUMPSITE (BARKINSALI)**

PLATE XXI **MAJOR DUMPSITE (TUNGA)**

PLATE XXII **MAJOR DUMPSITE (TUNGA)**

PLATE XXIII **TUNGA**

PLATE XXIV **MAJOR DUMPSITE (CHACHANGA)**

PLATE XXV **DRAINAGE DUMP (LIMAWA)**

PLATE XXVI **MINOR DUMPSITE (KATERI GWARI)**

PLATE XXVII **MINOR DUMPSITE (TUNGA)**

PLATE XXVIII **DRAINAGE DUMP (TUNGA)**

PLATE XXIX **MAJOR DUMPSITE (SOKAKAHUTA)**

PLATE XXX **MAJOR DUMPSITE (BARKINSALI)**

PLATE XXXI **MAJOR DUMPSITE (MAITUMBI)**

PLATE XXXII **MAJOR DUMPSITE (MAIKUNKELE)**

PLATE XXXIII **MINOR DUMPSITE (EASTERN BY PASS)**

PLATE XXXIV **MAJOR DUMPSITE (KASUA GWARI)**

PLATE XXXV **MINOR DUMPSITE (ANGWAN DADI)**

PLATE XXXVI **KPAKUNGUN**

PLATE XXXVII **PLASTIC COLLECTION SITE (TUNGA)**

PLATE XXXVIII **PLASTIC COLLECTION SITE (TUNGA)**

TERMS USED IN RECYCLING

Primary Recycling

This is the return of a secondary material to an application similar to its original use, thus it is processed to yield the same or a similar product, for instance, the return of broken plastic pipes to plastic pipe manufacturing plant for the production of new ones.

Secondary Recycling

This is the use of a secondary material in an application other than its original use. Example includes the reprocessing of waste plastics into plastic toys.

Secondary Materials

These are those that have fulfilled their useful function and cannot continue in use in their present form or composition. Alternatively, they may occur as waste from the manufacturer or conversion of products.

Reprocessing

This is the activity of changing the condition of secondary material, whether the change is minor such as crushing or shredding, or major such as conversion of polystyrene to form cups etc.

Recovery or Salvage

This is the act of obtaining a secondary material whether by collection as litter, by sorting from otherwise discarded materials, by disassembly or by some other activity. More broadly, this term used to 'both salvage as a material' is a technical

term signifying a quantity of materials, sometimes of mixed composition that is no longer useful in its present condition or at its present location. It is however capable of being recycled, reused, or used in other applications.

Reuse

This is the return of a commodity or product into the materials stream for use in exactly the same kind of application as before without any change in its identity. A familiar example is returnable beverage plastic container which is washed, refilled and returned to the market place.

Pyrolysis

This is the use of heat to breakdown complex chemical substances into simpler substances. Example, the burning of nylon to for the production of fuel oil.

Questionnaire

Below also is a specimen questionnaire that will be administered to the respondent by personal interview.

1. Address or Location.....
2. Type of house you live in.
    a. One room apartment/self contain.
    b. One bedroom flat
    c. Room and parlor
    d. Two bedroom flat
    e. Duplex room flat
    f. GRA
    g. Low cost estate
    h. High rise building
3. Please respond to the following one that relates to you
    a. I own a shop stand in the market
    b. I own a shop in a shopping complex
    c. I work in a bank
    d. I work in a ministry
    e. I am a trader
    f. I live close to my eatery or cafeteria
    g. I work in a private office
    h. I am a student (tertiary institution).
4. Plastic waste type generated
    a. How much nylon, pure water sachet, black nylon bags, plastics bottles and other plastic materials do you dispose after use daily.
        i. Very much
        ii. Quite much
        iii. Little
    b. How do you dispose them?.....
    c. Do you have a dustbin in your premises?.....
5. Underline true or false which is applied to you
    a. Is your refuse removed by Alif maintenance true or false?
    b. Is your refuse removed by Niger State Urban Development Board (NSUDB) true or false?

6. How often do they remove it?
    a. Weekly
    b. Twice a week
    c. Once a month
7. If 'false', how often do dispose your refuse?
    a. Private refuse dumps
    b. Public dumps
    c. Other means
8. Do you like the sight of refuse on the street? Yes or No
9. Do you like to live near a refuse dump? Yes or No
10. Which of the following is the most prominent among the refuse generated that cause problems in your surrounding?
    a. Plastics waste (Nylons, Plastic bottles, and others).
    b. Glass
    c. Paper
    d. Metal
    e. Food items/leaves
11. Are you aware that refuse dumps cause diseases? Yes or No
12. Do you have any ideas on how your refuse are disposed? Yes or No
13. Are you comfortable with the disposal method in your surrounding? Yes or No
14. Are you aware of recycling of waste? Yes or No
15. Would you like to separate waste paper, plastics, food items, metals separately in different bins, in other to encourage recycling?
    a. Yes
    b. No
    c. Neutral
16. Would you like to buy recycled products? Yes or No
17. Do you believe recycling of waste is the most environmental friendly? Yes or No
18. Don't you think recycling is a big business?_____
19. How would you like to contribute to the recycling of plastic wastes? _____