# COMPOST MANUFACTURING INDUSTRY, KANO: TOWARDS REDUCING MAINTENANCE PROBLEMS IN COMPOSTING INDUSTRIES

BY

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## DECLARATION

I, Bashir Abubakar Muhammad, of the Department of Architecture, Faculty of Environmental Design, Ahmadu Bello University, Zaria-Nigeria, do hereby declare that the work presented in this thesis work is a personal academic work, undertaken under the kind joint-supervision of Professor (Arc.) F.W. Schwerdtfeger and Arc. M.H. Mukhtar both of Department of Architecture, Faculty of Environmental Design, Ahmadu Bello University, Zaria-Nigeria. The work has not been accepted either partially or wholly in any previous application for a higher degree and that all the utilized quotations, information and their sources have been duly acknowledged by way of references.

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Bashir Abubakar Muhammad Date

## CERTIFICATION

This thesis report, entitled Compost Manufacturing Factory, Kano: Towards reducing maintenance problems in Composting Facturies, by BASHIR ABUBAKAR MUHAMMAD meets the regulations governing the award of the degree of Master of Science in Architecture of Ahmadu Bello University, Zaria-Nigeria and is approved for its contribution to knowledge and literacy presentation.

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## DEDICATION

With love and appreciation, this work is dedicated to my parents Alhaji Muhammad Bashir and Hajia Maimuna Ya'u for their adoration, care, understanding, lots of concern and moral and financial support of my education.

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## ABSTRACT

Industrialization is a major process for economic development of any nation. The present economic situation has prompted the Federal government to seek for ways of diversifying the economic base, hence the emphasis on industrialization and agricultural development.

A significant challenge confronting engineers, scientists and environmentalist in developing countries is the search for appropriate solutions to the collection, treatment, and disposal or reuse of domestic waste. Much of this waste ends up littering road sides, floating in lakes, and streams and collecting in ugly dumps. The magnitude of the problem demands a complex organizational set up to solve the problem.

Waste recycling helps in reducing the waste by turning the waste materials into new useful materials. Organic matter which forms about 70% of the refuse can be processed into compost (organic fertilizer).

The role of the architect here is to design a factory house the composting process.

This proposed factory is expected to produce about 60,000 tones of compost fertilizer annually and will offer for sale its salvageable like scrap metals, glass, plastics, polythene bags and so on.

Experience shows that the blending of good planning and maintenance, efficient construction and pleasant appearance, when applied to industrial buildings does produce happier and healthier working environment for the workers.

A major challenge facing composting industries is maintenance problem. The main causative factors of maintenance problems in industries range from poor design details, services, poor construction materials to poor workmanship. However, evidence has shown that it is at the design stage that the burden of maintenance problems could be made for better or for worse. The idea here is to bring out a synthesized design that would invariably reduce maintenance problems.

To carry the citizens along with the agricultural programs, there should be a ready market and a good one for that matter, for any agricultural product right where it is produced or where the potentials for producing them exist. This will help in stimulating the production, as well as serve as a dual purpose of industrial and agricultural developments.

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# CHAPTER ONE

# INTRODUCTION

## 1.1 Introduction

The greatest environmental problem facing majority of the urban centers in Nigeria today is the unprecedented growth/accumulation of the quantity of waste products. Waste matters from industries, biomedical centers and drug laboratories, agriculture and so on, posit a lot of threat to our immediate environments. So also refuse dumps from the municipal, improper sewage/drainage systems, demolition debris and other sludge residues are all factors that make our environments look unhygienic and sometimes inhabitable.

Therefore, one of the serious concerns here is the poor and inefficient management of these wastes. Everywhere is littered with garbage as a result of people's improper disposal of their domestic wastes into drains, streams and roads. And the governments seen incapable of effective and efficient management and control of this societal problem. Alongside this environmental problem, have emerged health hazards posed by the mounting waste heaps that are wasted or dumped at the dumpsite and at the same time when poverty is ravaging the nation. The inadequate management of waste has turned waste into a monster in most urban centers in Nigeria and in most cities in Africa. (Onibokun,1999). The magnitude of the waste problem has been such that it has

generated a lot of interest and has become one of the critical areas of concern to all levels of governments, donor agencies, NGOs, the organized private sector, urban researchers, public health managers and environmental crusaders in general. (Hussam, 2002)

This issue has become so critical that most people, especially those in urban areas are disturbed on how to device a means of control whether by government or individuals. Though wastes have negative economic value but sometimes valuable materials are dumped with actual waste, which in turn pave way for informal scavenging by poor people who wallow in search of materials that are relatively good or have a second class value. In fact, these people who are mostly peasants and toilers earn their living through this means. They have no alternative because they are poverty stricken.

A cursory look at the wastes generated in all the urban areas indicates that the organic portion of the wastes constitutes between 60 and 70 per cent of total wastes generated. Plastic and nylon accounts for the second major component followed by scrap metal and glass. It is also observed that at every major dumpsite, informal scavenging goes on uninterrupted and a majority of the low-income population resort to these sites for making a living particularly when they do not have education and skills. In addition, the current situation in the country is such that many industries potentially interested in reusing or recycling the wastes, as raw

materials, are handicapped because of difficulties in obtaining adequate raw materials, particularly at economically viable price. This situation promotes more and more opportunities available for the informal sector to go into wastes recycling ventures.

Recycling in it narrowest and probably original sense denotes the return of a discarded material to the same product system, such as return of waste paper to make new paper.

Experience from other countries have shown that it is possible and advisable to tackle the problem of urban waste and poverty through an approach which treats waste as resource materials which can be recycled to create new usable products, thereby creating employment through the process of conversion of waste to wealth (recycling). Again, experience has revealed that what we all take or see as "waste" around us have residual economic value especially in terms of reuse and recycling. For example, market waste, used materials, including paper and paper-carton, textiles, glass, plastic, metals and wood, (almost all we throw-away) have great potentials for re-use, they can be recovered and recycled. In the process, the environment is made cleaner and jobs are created for the recyclers, as well as for the processors of such recycled materials.

It is on realization of this, that it became necessary to explore the feasibility and the technical options for waste management and waste recycling in Kano State, with particular interest in finding the

best combination from the disposed urban waste to be used for the production of compost manure. This is considered as part of solving the problems of waste management and promoting community-based waste recycling as a means of cleaning the environment, while promoting economic activities that will assist in the reduction of poverty associated with most urban centers in Nigeria, and improving agricultural production in the state.

Today, it is the practice of many industrialists to ignore the human values of their workers so as to maximize profits technically and financially, yet these industrialists forgot that these gains could not be reached if effective hygienic and well maintained environment is not provided.

A lot of composting industries have exposed their workers to excessive unpleasant odour, poor maintenance and deteriorating sanitary and hygienic conditions such as inadequate facilities, poor landscaping, improper planning and orientation, health hazards, poor drainage and so on.

Besides, farmers practicing traditional composting have also been exposed to pathogenic disease infections involved in the process and also as a result of micro-organisms present in the raw waste.

The architect therefore has a great role to play in ensuring that his design is maintenance-oriented. Maintenance has to do with the good performance of the different parts of the industry, odour

control, well-being of the workers as well, protection from hazards and injuries, comfort and waste disposal.

## 1.2 **Statement of the Problem**

The architect's role in encouraging good maintenance culture, maximum odour control and sanitation practices in compost manufacturing industries can not be over emphasized. Sanitation and good maintenance oriented planning and construction is more important than sanitation methods since it encourages sanitation practice.

This thesis is to investigate possible ways of creating effective planning for maintenance, sanitation and hygienic environment in compost manufacturing factory. It will also find out how certain architectural design aspects like industrial planning and structure can enhance sanitary levels in compost manufacturing industries and how pathogenic disease infections among healthy workers can be avoided.

## 1.3 **Aims and Objectives**

The aim of this is to propose an urban compost manufacturing factory considering some architectural solutions by creating a hygienic environment for both the waste management and organic fertilizer production. The aims can be summarized thus:

1. To create a hygienic working environment in the waste recycling plant so as to prevent pathogenic disease infections.
2. To create a comfortable; hazard-free and conducive occupational environment.
3. To achieve an efficient and effective spatial and functional integration of the different industrial units to enhance and maximize operation efficiency.
4. To promote agricultural production and economic activities.
5. To have a pollution free environment and reduce maintenance problems and public health hazards.

The aims are hoped to be achieved by consideration of these objectives.

1. Consideration of maintenance and sanitary requirements through the planning and design process.
2. Consideration of comfort and safety criteria in the design.
3. Identifying the existing sanitation problems in other relevant industries and creating architectural solutions to them.
4. Developing an adequate planning scheme for effective spatial and functional organization.
5. Considerations to minimize initial cost of the project to ensure its viability.

6. To identify a suitable architectural planning that will suit the purpose of Sanitation as regards comfort, safety, good sanitary conditions and waste disposal.
7. To identify and sort out recycling materials common in the waste that are in need by society and other industries.
8. Provision of a complex which will encourage growth and sustainability of the composting effort.

## 1.4 **Motivation**

Motivation arises from the sheer size of the growing waste dumps at every place in Kano versus the sheer size of population growth. It is also believed that once economic rewards can be perceived in urban waste recycling, there will be human participation induced by population of jobless people. The research topic, designing for effective hygienic environment, was motivated from the need to control the disintegrating hygienic conditions in our recycling industries and also to protect workers against pathogenic disease infections involved in composting.

It is also motivated by seeing the feasibility of establishing an industry like compost manufacturing industry at an inland where the potentials of the raw materials is not exploited and there is shortage of fertilizer.

## 1.5 Justification

Kano State an ever-growing settlement by innate qualities is a strong centre of commercial activities. Kano in return will continue to generate waste. Kano State lacks space and consumption of growing sites for waste disposal versus human settlement is not a good option. The waste dumping sites were estimated at initial stage to last for ten to twenty years but some got filled up in the first five to ten years. This is due to the poor method of dumping.

Estimates prepared by the department of sanitation, Ministry of Environment shows that monies spent for refuse collection alone in the state for the year 2000 are in the order of about N15 million from the ministries budgetary allocation. This huge sum was only for the maintenance of heavy plants tippers, purchase of diesel, and repair works of some refuse collection buckets. (Hussam 2002).

Out of the 14,000 tones of refuse generated daily within the 8 metropolitan areas of the state, an average of 96 trips (480 tone) of refuse is been evacuated on a daily basis totaling to 30,000 trips annually translated into monetary figures of N426.91 per trip and N40,983.6 per day.

If the present population will generate 5,110,000 tone of refuse annually and at the cost of N40,983.60 per day, then it is evident that the use of an alternative method of turning the waste that ends up in the dump site be used in away that it will bring some monetary benefit to the state or to at least supplement the

management aspect of the program by offsetting at least half of the amount spent on the program, at the same time providing jobs and other materials that can be re-used.

The first idea that may come to mind is waste recycling and the use of the organic material present in the disposed up waste. The organic material in the unwanted waste, forms the bulk of municipal waste, while 46 percent of the waste flow is garden (vegetable) waste which can be used to fertilize and enrich farm lands and the degraded soil. Organic matter in developing countries accounts for 50-70 percent of the total waste stream. (Onibokun,1999).

The diminishing agricultural production and inadequate waste disposal can be seen as problems of the rural and urban sectors respectively. Cities produce large volume of organic waste, while farms consume great quantities of chemical fertilizes. The urban sector dumps waste in landfills, waterways, and stream while the rural sector depends only upon the inadequate imported chemical fertilizers, which can be sourced locally through recycling the wasted waste.

In some parts of the country, the waste utilization has been going on but without any scientific approach to convert into compost which is rich in plant nutrients and hygienic. This has resulted in poor hygienic environment, pathogenic disease infections, poor storage and poor waste disposal.

The architect has a great role to play in providing a suitable architectural planning that will suit the purpose of hygienic as regards comfort, safety, storage good sanitary condition and waste disposal.

In conclusion, Kano State presently has the relevant policies that support sustainable development on environmental issues, which is the legal backing needed. A well-planned strategy is all we need to activate the policy.

## 1.6 Scope

The scope of the thesis is limited to refuse collected within Kano metropolis. That is a segment of a broader category of solid waste in general. The thesis is an attempt in solving architectural problems with regards to sanitation in compost manufacturing industries.

The industrial process will involve sorting out the different materials in the waste such as plastics, glass, and paper for use by other industries. The remaining organic matter content will then be composted into an organic fertilizer.

Sanitary consideration will particularly be given to the production hall and storage areas. The Industry comprises of the following :-

1) Administrative Block

2) Production Hall

3) Workers' Facilities

4) Storage Area

5) Auxillary/Ancilliary Facilities

6) Parking Space

## 1.7 **Limitations/Constraints**

Some of the constraints encountered during the research so far include the following:

1) There is limitation on the level of information to be given by the industries visited. Photography was strictly forbidden in the industries.
2) Seeing that it is a new area of inquiry, the time needed to gather all the data is lacking.
3) There are very few or nil number of waste recycling industry that produce organic fertilizer.
4) Financial limitations exist due to the number of visits that can be embarked upon.

## 1.8 **Methodology**

The method of collecting data and the sources will involve visiting the existing industries and conducting oral interview with the various personnels that are involved in running different parts of the industries. Research will also be made in relevant textbooks, newspapers, Internet and journals from the library. Concerning the

proposed site, data relating to it will be obtained from recorded sources and through visual survey of the site.

## 1.9 **Architectural Significance**

The architectural significance is firstly the provision of the space envelope, which is functional, and also creating a comfortable and hazard free environment for the maximum efficiency of workers.

Secondly, the design provides a properly organized production process and zoning of units to ensure effective sanitation. This will promote the production of compost fertilizer on a large scale.

The thesis is hoped at being a source of encouragement to Kano State government (and other investors) and a working model for architects who equally have interest in designing waste recycling industries and in particular for compost manufacturing.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1.0 WASTE

### 2.1.1 Waste Definition

Waste is a physical phenomenon encountered daily in our routine consciously or sub-consciously solid waste is a major source of concern for most cities and centers of urbanization in our world today.

The word waste refers to useless, unused, unwanted or discarded materials. According to United Kingdom Control of Pollution Act 1994, "Waste is defined as any substance which constitutes scrap materials or effluents or other unwanted surplus substance arising from the application of any process. It is any substance or article which requires to be disposed off as being broken, worn out, contaminated or otherwise spoiled and for the purpose of pollution control, any thing which is discarded or dealt with as if it were waste shall be presumed to be waste unless the contrary is proved." (Adekunle 2001)

Waste includes solid, liquids and gases: the gases are principally industrial fumes and smoke, the liquids consist mainly of sewage and the fluid part of industrial waste, the solids are classified as refuse. The focus of this paper is on the refuse waste.

According to Perry (1997) "Refuse, sometimes referred to as Rubbish, consists of combustible and non-combustible solid waste.

Combustible materials include papers, cardboard, plastics, textiles, rubber, leather, wood, e.t.c. Non-combustible items include glass, tin cans, aluminum cans, ferrous and non-ferrous metals." (Odeh 2002)

### 2.1.2 Waste And Environmental/Health Problems.

Wastes are any unavoidable materials resulting from domestic, agricultural or livestock activities, or industrial operations. They have no economic demand and must be disposed off. They emanate from human actives such as domestic, agricultural or industrial liquid wastes and the leachates from solid wastes are highly organic in nature, may also contain certain levels of hazardous materials depending on the source. They may enter soils, and surface and ground waters and alter their natural characteristics thus affecting their quality and productivity. Gaseous wastes, though not strikingly visible, may affect the health of communities residing or working in the vicinity, may bring in climatic changes, rise in sea/ocean levels, and ozone depletion. Gaseous wastes may also originate from urban wastes due to burning activities. In Nigeria, at the current level of development, solid wastes are particularly of great concern as they are unsightly in urban and rural centers, and attract the attention of many.

Indiscriminate disposal of solid wastes which is the normal practice in many urban centers, causes damage to the environment

and affect health of the communities. Environmental damage may occur in the form of ecological disturbances such as:

- Blockage of drains and stream flows resulting in flood disasters
- Fire hazards when the wastes are dry
- Obnoxious smell, gaseous and smoke emissions
- Breeding site for rats, flies and other vectored of public health importance
- Offers a venue for stray animals, destitutes, and lunatics
- Death of useful flora and fauna of aquatic or terrestrial systems
- Biodiversity
- Morbidity or mortality of populations due to injuries and infections.

The solid wastes, particularly the municipal solid wastes, crop residues, and livestock dungs are rich in organic mater and other essential nutrients such as nitrogen, phosphorus and potassium and micronutrients. They are highly putrescible and favour breeding of flies and harbour Tetanus, Clostridium, and other infection agents. The leachates may promote mosquito breeding when stagnant. These wastes are normally associated with other wastes from human activities, such as metals, glass, plastics and a host of utilities. However, some of them have great recyclable values if properly collected and utilized.

## 2.2.0 Refuse Waste Recycling

### 2.2.1 Introduction

Recycling is the collection, processing, and reuse of materials that would otherwise be thrown away. Materials, ranging from precious metals to broken glass, from old newspapers to plastic spoons, can be recycled. The recycling process reclaims the original material and uses it in new products.

In general, using recycled materials to make new products costs less and requires less energy than using new material. Recycling can also reduce pollution, either by reducing the demand for high-pollution alternatives by minimizing the amount of pollution produced during the manufacturing process. Recycling decreases the amount of land needed for trash dumps by reducing the volume of discarded waste.

### 2.2.2 **Types Of Materials Recycled**

On an industrial scale, the most commonly recycled materials are those that are used in large quantities-metals such as steel and aluminum, plastics, paper, glass, and certain chemicals.

1. **Steel**

There are two methods of making steel using recycled material ; the basic oxygen furnace (BOF) method and the electric arc furnace (EAF) method. The BOF method involves mixing molten scrap steel in a furnace with new steel. About 28 percent of the new product is recycled steel. Steel made by the BOF method typically is used to make sheet-steel products like cans, automobiles, and appliances. The EAF method normally uses 100 percent recycled steel. Scrap steel is placed in a furnace and melted by electricity that arcs between two carbon electrodes. Limestone and other materials are added to the molten steel to remove impurities. Steel produced by the EAF method usually is formed into beams, reinforcing bars, and thick plate.

Approximately 68 percent of all steel is recycled making it one of the world's most recycled materials.

2. **Aluminum**

Recycling aluminum in the united state provides a stable, domestic aluminum supply amounting to approximately one-third of the industry's requirement.

Cans brought to collection centers are crushed, baled, and shipped to regional mills or reclamation plants. The cans are then shredded to reduce volume and heated to remove coatings and moister. Next, they are put into a furnace, melted, and formed into

ingots, or bars, weighing 10,000 kg (30,000B) or more. The ingots go to anther mill to be cans are formed. The cans are printed with the beverage's logs and are shipped (with tops separate) to the filling plant.

About 100 billion aluminium beverage cans are used each year in the United States and about 65 percent of these are then recycled.



Figure 2.2.2a Recycling of Aluminium

Source : Encarta Encyclopedia 2003

3. **Paper And Paper Products.**

Paper products that can be recycled include cardboard containers, wrapping paper, and office paper. The most commonly recycled paper product is newsprints.

In newspaper recycling, old newspapers are collected and searched for contaminants such as plastic bags and aluminium foil. The paper goes to a processing plant where it mixed with hot water and turned into pulp in a machine that works much like a big kitchen blender. The pulp is screened and filtered to remove smaller contaminant. The pulp then goes to a large vat where the ink separate from the paper fibers and floats to the surface. The ink is skimmed off, dried and reused as ink or burned as boiler fuel. The cleaned pulp is mixed with new wood fibers to be made into paper again.




Figure 2.2.2b  Recycling of Papers

Source : Encarta Encyclopedia 2003

4. **Glass**

Scrap glass taken glass manufacturing process, called cullet, has been internally recycled for years. The scrap glass is economical to use as a raw material because it melts at lower temperatures than other raw materials, thus saving fuel and operating costs.

Glass that is to be recycled must be relatively free from impurities and sorted by color. Glass containers are the most commonly recycled form of glass, and their colors are flint (clear), amber (brown), and green. Other glass, such as window glass, pottery, and cooking utensils, are considered contaminants because they have different compositions than glass used in containers. The recycled glass is melted in a furnace and formed into new products.

5. **Recycling plastics**

There has been a growing concern that waste plastics may become a global pollution hazard. But presently plastic is the most recycled material. The plastic types are sorted according to their recycling number, batch or plastic type and color. They are then turned into shreds with the crushing machine. These are then immediately turned into the funnel of the recycling machine of choice-mould and product, these machines melts the shredded wastes plastics and pumps the molten plastic into a mould that

makes it into different plastic shapes. The desired colour is mixed with the material before turning into machine.



Figure 2.2.2c  Recycling of Plastics

Source : Encarta Encyclopedia 2003

**6. Organic waste (composting)**

Haug (1980) defined composting as the biological decomposition and stabilization of organic waste (substrates) under conditions which allow development of thermophilic temperatures as a result of biologically produced heat, with a final product sufficiently stable for storage and application to land without adverse environmental effects. Another definition, recently agreed in Europe, refers composting to a controlled aerobic process carried out by successive microbial populations combining both mesophilic and thermophilic

activities, leading to the production of carbon dioxide, water, minerals and stabilized organic matter. Generally, composting is applied to solid and semi-solid organic wastes such as nightsoil, sludge, animal manures, agricultural residues, and municipal refuse.

A versatile material, compost benefits virtually any soil type. Clay soil, for example, has tiny, tightly packed particles that hamper the flow of water, nutrients, and oxygen. Compost reconfigures the clay into larger, more loosely packed particles. The larger spaces between the particles improve the flow of water, oxygen, and nutrients to roots. In addition, the roots are able to penetrate deeper into the soil and contact more nutrients. Compost also improves sandy soil, where the large spaces between loosely packed particles enable water and its dissolved nutrients to drain too quickly for optimum root absorption. Compost soaks up and holds these substances so that the roots have more time to absorb them. Compost also adds small amounts of zinc, copper, boron, and other vital nutrients to soils.

### 2.2.4. **Recycling Activities**

Recycling and its activities may be grouped into 3:

1. Physical Sorting
2. Reprocessing Manufacturing
3. Biotechnological Conversion

1. **Physical Sorting**

As the name suggest, involves sorting, using the physical characteristics of the wastes, broadly grouped into plastic, metallic, glass, textile, wooden and paper products, among others. Such product in a number of circumstances lend themselves to reuse after thorough cleaning and disinfecting, as in the cases of bottles, cans, rags and other items of furniture.

**TABLE 2.1: RECYCLABLES AND THEIR USES FROM SOLID WASTES**

| **WASTE** | **RECYCLABLE VALUE OR USE** |
|---|---|
| Hair, Bristles, wool, Feather | Brushes, lanol, fertilizer, wigs, blankets, carpets and fabric |
| Hoofs, Horn | Buttons, combs, hairpins, novelties, washers, glue, gelatin |
| *Bones* | Buttons, cutlery, Handles, ornaments, Glue, Gelatin, Bone |
| Hides, Skins, feet | Horses whips, seats, hand bangs, Book binding, Shoes, |
| Intestines | Stock feed, surgical ligature, musical (Guitar) strings, Tennis |
| Blood | Fibrin form, purified bovine albumin, dried blood and blood |

| | |
|---|---|
| Ruminal contents, Excreta | Methane gas, Manure |
| Fats | Soap, Machine oil, candles, leather dressings |
| Glands and special organs | Pharmaceutical products (Insulin, Gall stones Corticosteroids |
| Aluminum | Soft drink and beer cans, Cutlery |
| Paper | Newspaper, packaging materials, various types of recycled materials. |
| Plastics (Various types) | Battles, milk jugs, pipes thin film packing, battery castings |
| Glass | Various glass products, decorative pieces |
| Ferrous metal | Tin cans, metal works |
| Non- ferrous metal | Aluminum, copper, lead, etc, various items |
| Yard wastes, organic wastes | Compost |
| Construction wastes | Filling materials |
| Tires | Road paving, building, shoe soles Recycling for lead and reuse |
| Batteries | Recycling for lead and reuse |
| Waste oil | Refuse after refining |

Source: Hussam 2002

This is usually based on waste separation at source. Material separation at source is among the factors promoting the utilization of waste at the municipal level. Before a material is processed for recycling, it is usually necessary to separate it from a variety of other materials. According to the UDBN (1995) study, separation is mainly based on unique physical and chemical properties such color, density and texture which are utilizes intuitively in manual sorting to magnetic properties which require mechanical equipment. The problem has been for African countries, that while the principle appears simple, there has not been the political will or enforced regulations to affect the practice. This notwithstanding, there is need to consider its practice, based on, for example, the popular unit process adopted by the U.S.E.P.A. in 1971 (Drobny et. 1971) and presented in the table below

Table 2.2. **Unit Process Separation Methods**

| **METHOD** | **MATERIALS** |
|---|---|
| Magnetic Separation<br>Inertial Separation<br>Ballistic Separation | Magnetic materials (iron)<br>Difference in size, density, elastic properties (depending on type) |
| Eddy-Current Separation | Conductive non-magnetic materials (copper, aluminum, zinc) |
| Electrostatic | Aluminum from glass; plastics, paper |

| | |
|---|---|
| Separation,<br>Size Classification | Preparation for further processing or rough cut |
| Air Classification | Light material, such as paper, from heavier materials |
| Gravity Separation | Glass from metals, paper from other material, and other separations based on density difference |
| Optical Sorting | Dirt from glass; separation of colored glass |
| Flotation | Air bubbles in liquid used to separate materials with differing affinities for air and fluids used |
| Cryogenic Separation | Difference between materials in tendency to become brittle at low temperature (e.g. liquid nitrogen). |

Source : UDBN, 1999

Although most of these techniques are technically sophisticated, the magnetic, gravity, optical and flotation processes are simple enough to enhance waste-to-wealth programs in most African countries.

2. **Reprocessing Manufacturing.**

This involves the reshaping, melting and mixing by physical actions, or in sophisticated cases, by chemical mixing and recompounding, as in the cases of metallic (aluminum and steel) wares and remilled paper/board products. Examples include

aluminum pots, spoon and spatulas manufactured through the melting of aluminum industry tail-wastes and molding into desired shapes.

3. **Biotechnological Conversions.**

This involves natural biodegradation processes, with highly organic materials as the starters (referred to as substrates). There are two major classes of such biodegradation processes, namely Composting and Biogassification. In composting, crop wastes and residues, municipal solid wastes, and certain aquatic weeds are converted into organic fertilizers through microbial action. In the biogas production, excreta from animals, and in some cases human faces sewage sludge are an aerobically converted into biogas, mainly methane. While the former is universally adopted, and dates back to pre-industrial revolution, the latter is widely used as intermediate technology in some developing countries and the recently emerging economies of South-East Asia. These products of biological/biochemical conversions and inter-conversions are environment-friendly in that they make for waste minimization of local energy needs. These processes do riot encourage massive environmental pollution as normally found in the manufacture of mineral fertilizers. They also prevent stench that emanates from putrefaction of animal dung piles and raw sewage discharge.

### 2.3.0 **Composting in Nigeria**

Urban and rural waste were disposed off or used in Nigeria a half century ago. In kano, refuse stable manure and market sweeping were disposed off by burning in incinerators, or mixed with night soil and converted into compost. Waste arising from cattle, donkey, horse, sheep and goat rearing were carefully conserved by the farmers and put back onto the farms as fertilizer. A nationwide survey by Sridhar (1989) revealed that some composting has been done in Kaduna, Kano, and Maiduguri areas in the past, but that it is no longer practiced on a large scale. The only large scale composting plant operated in kano between 1936 and 1942 was under the supervision of Dr. Grilles (1946). Night soil and city waste were used. The survey further revealed that other materials are being used in other parts of the country. Such materials include stalks of various crops (corn, guinea corn, surghum); rice husks; wheat straw; vegetable peelings; cotton stalks; grasses; cocoa and banana leaves; excreta from poultry; cows; piggery; sheep and goats; ashes; and waste from slaughterhouses, breweries and other industries which process organically rich materials (Sridhar et al, 1993).

Further elaborated studies conducted in Ibadan (Sridhar et al, 1992; Adesoye et al, 1993); revealed that composting is a feasible way of converting the available organic waste into organic manure, and that a variety of crops such as Yams, Maize, Green amaranth ,

and a variety of fruit crops could be grown which will yield better crops as compared to those grown on inorganic fertilizers alone. The experiments are further extended to involve inorganic supplementation and also to involve the communities to appreciate, to prepare on a small scale, and use the manure on their farms. The emphasis was on the use of domestic refuse and animal wastes as basic materials in the production of bio-fertilizer. The aerobic method of composting through surface windrowing was proved to be more efficient in reducing the cost, time of composting and retaining the nutrients to a great extent.

Further elaborate studies conducted by an "organo-mineral fertilizer research group" at university of Ibadan, has revealed that composting is a feasible way of converting the available organic wastes into organic manures, it can be supplemented with other plant nutrients, and can be converted into pellets. (Sridhar, 1998).

More recent studies conducted in 1995 showed that the pellets which can easily be handled by small scale farmers to carry and use on their farms can be simple, cheap and has the added advantage of slow release of the nutrients when applied to the soil and the volume will be reduce drastically for easy handling by the farmers. A simple manually operate, pelletizing machine was fabricated and used. It is designed for preparing 32 pellets with dimensions 6.4 cm long, 2.0 cm diameter with a volume of 20.11 cm3 and each weighed 29.5 grams when dried. The freshly

prepared pellets may be sun-dried and stored before use. The pellets were stable even after two years of storage under tropical humid conditions as in ibadan. The colour of the dried pellets was dark reddish brown and can vary depending on the binding agent used in the process. The advantage of pelletization is in the reduction of weight and volume of the original composts. The reduction in volume of the freshly made and that which was air died compost used here was 70.5 and 54.5 percent. The corresponding weight reductions for the same were 58.2 and 28.6 per cent. (Sridhar, 1998)

### 2.4.0 Composting Technologies.

Several technologies have been used to compost biosolids; they are typically categorized as windrow, static pile and in-vessel systems.



**Figure 2.4a Open windrows.**

### 2.4.1 Windrow Systems:

The windrow composting process calls for the compost mass to be placed in manageable windrows that can be turned to allow aeration.

Windrow composting may allow for rapid drying of the compost mass, as moisture is released when piles are turned. The system has the capacity to handle large volumes of material and provide good product stabilisation. Windrowing also possesses a relatively low capital cost. However equipment and equipment maintenance costs can be significant, depending on the pile turning equipment utilised. Windrow systems are not very space efficient, requiring substantial space between rows for turning equipment. Pile sizing should not exceed approximately 1.5 meters in height and 3.5-4 meters in width. Unless piles are extremely porous, passive aeration in windrows may not be sufficient to maintain aerobic conditions. Poor aeration may cause low or non-uniform pile temperatures, pathogen survival and odours. Odours also tend to be released whenever piles are turned, and odour management is difficult with this system (unless piles are housed in a building with air-handling controls). Windrows can be influenced by the weather and process rate will fall slightly in winter. Perhaps more importantly in Scotland, under wet conditions, pile temperatures can be reduced, thus reducing process efficiency, and so feedstock preparation (mixing of biosolids and bulking agents) may be problematic.

### 2.4.2 **Static Pile Systems:**

Unlike larger unturned static piles of garden waste, biosolids should be actively aerated during composting. The aerated static pile (ASP)

composting process calls for manageable windrows to be formed over an aeration plenum, pipe or trench. The compost mass is then covered with a layer of finished compost, to act as an insulating blanket.



**Figure 2.4b Static Pile.**

Air is pulled (negative) or pushed (positive) through the pile, to provide aeration, and the pile is therefore not turned (Figure 6). By operating under negative aeration, process air can be captured and treated, for instance through a simple biofilter. ASP composting requires relatively low capital cost, with the greatest expense going towards surfacing and material handling and loading equipment (front end loaders). The system can provide fast and thorough pathogen destruction, and good product stabilization. ASP composting can also provide better odour control than can outdoor window composting. However, ASP composting still possesses a greater odour generation potential than do in-vessel systems, and operations may still be influenced by climate, particularly cold and

wet weather. To minimise these issues, today, more ASP systems are being housed within buildings. The system has greater land requirements than in-vessel composting, but lower than windrowing.

### 2.4.3 **In-Vessel Systems:**

Various types of in-vessel composting systems exist which may be used to process biosolids. Edwards (1998) categorises in-vessel systems as agitated bays, container systems, tunnel systems and enclosed halls. Each system has its own set of advantages and disadvantages, but the agitated bay, tunnel and larger container technologies have been the most popular in-vessel systems used for composting biosolids. However, aside from patented technologies, the operation of windrow and ASP systems within a building is also becoming popular.



**Figure 2.4c In-vessel tower system.**

In-vessel systems typically require the lowest land requirements, being very space efficient. They can provide good odour control because exhaust air can easily be directed to biofilters. In-vessel systems also are less affected by climate than either windrow or static-pile systems, can allow for better process control, but have much higher capital costs. These systems rely on specialized mechanical equipment, which may require specialized repair knowledge. In-vessel systems typically do not allow for proper stabilisation within the 'vessel' and outdoor curing is still required. In this system, composting is carried out within an enclosed space. It is very important that any in-vessel system allows for proper aeration of the entire composting mass and this will influence choice of feedstock mix, to minimise compaction. Additionally, some tunnel systems have proven difficult to provide uniform aeration and process control.

# CHAPTER THREE

# CAUSES AND PROBLEMS OF MAINTENANCE IN INDUSTRIES

## 4.0 INTRODUCTION

Building maintenance can be defined as the work undertaken in order to keep or restore every facility i.e. every part of a site, building and contents to an acceptable standard. Acceptable standard here refers to the state of the building in which it satisfies its requirements, functionality, technically and aesthetically.

Buildings which are entirely maintenance free are ideal but every material used in construction is subject to deterioration through weathering and/or ageing. The cumulative effects of climate, fire, constructional methods and users, causes the deterioration and erosion of the building fabric. All buildings start to deteriorate from the moment they are completed and from that time begin to need maintenance, in order to keep them good condition. A building is consistently attracted from all sides, outside and within; the structure settles down; materials swell and shrink; expand and contract; air and water borne chemicals and dirt attack surfaces causing discoloration and corrosion; normal wear and tear soon have an effect on al parts of the building; floors and walls lose their original sheen.

The problems of building maintenance concern clients, architects and builders alike, and each can play an important role in minimizing the maintenance needed in a completed building.

### 3.2.0 **CLIMATIC INFLUENCE ON INDUSTRIES**

The climatic condition of a site if not well analysed by the architect may result to maintenance problems in the industry. Climatic conditions always have special significance in respect to the external features of the building. In some other case, the internal elements and finishes of the industrial building react to the climatic conditions of the site too.

### 3.2.1 **RAIN, AIR, WIND AND MOISTURE**

The penetration of a building's shell by air borne moisture is associated with two climatic factors, rain and wind. Without wind the ratio would fall vertically, barely wetting a building's roof and wall; without wind, their would be little or no air pressure difference between the inside and outside of a building shell. The penetration of a building shell by air borne moisture can result from;

i. The absorbency of the material of which the roof and wall are made of;
ii. Failure of the joints between elements of the shell made of, the same material;

iii. Failure of the joints between elements of the shell made of different materials.

Uncontrolled weakening and even a normal one can lead to physical decay and deterioration, resulting in the need for an abnormal amount of repair and renewal, and often leading to a change in the appearance of the industry. In most cases this is usually to the detriment of the original design.

The effect of rainfall on roofs can easily show its performance. a high proportion of buildings nowadays have flat roofs. These often fail to give satisfactorily services for a number of reasons. Roofs have been said without falls and, although this is not inherently bad, it is recommended that normal falls are the best practice. Due to deflection of the structure, some roofs laid flat now have reverse falls leaving the outlets at high points causing ponding and providing a reservoir for leakage to occur.

### 3.2.2 **TEMPERATURE**

Air temperature and thermal comfort are affected by sun, wind and precipitation. Thermal movements in industries are due to temperature changes of the building material thereby opening up paths for moisture penetration, and producing cracked wall, cracked floor surfaces, ill-fitting doors and windows. It must be realized that expansion joints and other devices are vital for the success of any design.

### 3.3.0 **FIRE IN INDUSTRIES**

Fire in industries can result to either complete demolition of the industry thereby prompting the construction of new ones or complete renovation of the affected parts of the industry. Essentially, the latter case is the one being considered here.

Nigeria, like any other developing country is witnessing an era of rapid economic and social reforms. This revelation brings with it new technologies, new materials and power sources with attendant fire hazards. Modern buildings, for example are housing more and more highly inflammable materials and sophisticated and costly equipments under one roof. Lighter construction systems and many new materials are being used. Inorganic materials are non-combustible, but a small quantity of organic fibre or binder is sufficient to render a material or component combustible.

The common causes of fire can be enumerated as;

- Misuse of electricity
- Electrical installation faults
- Indiscriminate disposal of glowing cigarettes ends
- Mishandling of flammable liquids, such as petrol, kerosene etc
- Ignorance and carelessness
- Enemy action.

It is generally considered by fire safety engineers that well maintained industries present lower fire risk. It is clear that maintenance has an important effect on fire safety.

### 3.4.0 **WORKMANSHIP**

Workmanship referred to the work which cover the total effort of the builder in erecting a building. It also includes his responsibility for using materials in good condition as directed by Architects in his specifications. Poor workmanship which results in the deterioration of the building is brought about by a combination of negligence and incompetence generated by insufficient skill or by differences to the job in hand.

Within the building trade, there are expected standards of workmanship which are closely related to the function of the industry. Workmanship is therefore an important factor in causing deterioration of an industry. Poor workmanship should be separated from faulty or detective materials. The responsibility is upon the builder (contractor) to use materials that are in good condition. Due to inaccuracies during construction, the fixings and bearings cannot tolerate the differential movement leading to structural defects. The juxtapositions of dissimilar metal causes electrolytic action unless precautions are taken to prevent contact.

Maintenance work is normally carried out through out the life of the industry and for this reason, the factor of workmanship extend over a larger period.

### 3.5.0 **DESIGN OF THE INDUSTRY**

It is at the design stage that the maintenance burden can be positively influenced for the better or for the worse. Poor design can increase the amount of maintenance work and also make it difficult to perform. When the designer does not make full use of the good of the good technical service provided by the manufacturer, the resulting building will have maintenance problem. Maintenance problems sometimes result from poor detail at the design stage, including insufficient allowance for expansion or contraction, absence of weathering or throating, lack of or incorrectly placed damp–proof courses, poor jointing between different components, inadequate falls, incorrect choice or misuse of materials, et cetera.

Faults in design cannot be cured permanently and as such remain a continuing nuisance throughout the life of the building. The causes of failure may result from insufficient consideration to performance in use aspects, such as the height of the production halls and the production processes. This situation may result in the creation of air currents which lead not only to an unpleasant environment within and around the industry, but also a severe strain on the fabric at unexpected points. Detailed design is of

paramount impact in all industrial buildings and many examples can be seen of industries which because of inadequate detailing at critical points, have failed to withstand condition of weather and normal use. An architect should be aware of the performance of the design details and elements that he specifies and materials out of which they are made.

A design failure can sometimes be attributed to the policy of the building owner who demands the lowest initial expenditure at the expense of performance.

### 3.6.0 **MATERIALS SELECTION**

Every material used in construction is subject to weathering and ageing. The rate of deterioration of the building materials differs from one another many building materials are porous and a common factor leading to the deterioration of a building is moisture. The odour generated during composting is also corrosive. The moist steam released corrodes the steel surfaces.

Some of the major maintenance problems stem from the use of new materials and techniques, whose nature does not adapt to the external environmental factors and internal usage of the building.

### 3.7.0 **BUILDING USAGE**

Another source of maintenance problem is the use of the industrial building. Wear and tear increases with intensity at use and may not

be adequately catered for in the original design. Deterioration due to use depend on the production activities, the machines behaviour and habits of the workers which are generally reflected in the function of the industry or part of it.

The factors of the use are related to processes and activities in each of the hall and their influence is much more on the internal elements than external elements of the industrial building.

# CHAPTER FOUR

# CASE STUDIES

## 4.0 CASE STUDIES SELECTION CRITERIA.

It is expected of any research work to study closely all project similar to the research, and that are available to him. The advantage of such detailed study is it enables the researcher to acquire practical and first hand information, which after analyzing will evolve with the good and bad aspects of them and hence help him produce a better alternative.

In the light of this, the researcher decides to choose the following existing industries, namely;

1. Bodija Composting Plant, Ibadan.
2. Kano Agricultural Supply Company, Kano.
3. Munich Waste Treatment Plant, Germany.
4. Composting Plant Impervia, Italy.

These case studies were chosen based on the fact that they are involved in either materials recycling or sorting and Composting. And hence they are relevant to the study. They are considered appropriate so that any problem due to poor design or improper design considerations for Odour control and Maintenance can be observed and corrected in the proposed design.

## 4.1.0 **CASE STUDY ONE**

## **BODIJA COMPOSTING PLANT, IBADAN.**

### 4.1.1 **INTRODUCTION**

This compost factory is a local indigenous company managed and operated by Oyo state government. It is located near Bodija market in the city of Ibadan. It has a good potential and a lot of benefits to the state government both in terms of Agriculture and environmental cleanliness. It is the first compost manufacturing factory in Nigeria. The factory was established to convert the vast refuse waste in the state into compost (fertilizer) using the windrow system.

### 4.1.2 **GENERAL PLANNING AND CONSTRUCTION**

The composting factory comprises of storage and production facilities and an administrative block. The two facilities are both provided under a shade. The shade is very wide, supported by timber columns partitioning it into different cells along the production process in accordance with the different functions. The width of the shade necessitates use of interdistant timber columns to take care of the span. This caused some distortion in the circulation and non free movement in the structure. The production line is hampered. It should have been an open bay like other

windrow composting industries, to achieve effective free movement of workers and goods.

The use of many timber columns with corrugated iron roofing sheets make the building uneconomical and aesthetically unpleasing due to the high rate of rainfall in the region coupled with poor maintenance attitude. The rainfall rust the roofing sheet causing leakages and gradually affect the strength of the timber columns. This shortens the lifespan of the structure.

Due the odour generated along the production process, wind movement supposed to be controlled. There is however a poor response to odour control. The leeward area is the same as the windward area. But ideally, the leeward supposed to be smaller than the windward area. The openings should also be made to channel the odour away from administrative block.

### 4.1.3 **MERITS**

1- The non permanence of the structure make the site adaptable to various schemes and developments.
2- The structure is made of readily available materials which made it low maintenance cost.
3- Adequate space is provided for future expansion.
4- It is low capital intensive.

### 4.1.4 **DEMERITS**

1- There is an inadequate provision of workers' facilities

2- Poor drainage of the site.

3- No free movement and circulation in the production area.

4- Poor odour control

### 4.2.0 CASE STUDY TWO

### KANO STATE AGRICULTURAL SUPPLY COMPANY (KASCO), KANO.

### 4.2.1 INTRODUCTION

The factory is located at Dakata within Bompai industrial layout. The company was established in 1976 to produce bulk blended N.P.K. mineral fertilizer. It is managed and operated by the Kano state government.

### 4.2.2 GENERAL PLANNING AND CONSTRUCTION

The zoning of the different areas of the factory is quite functional. Noisy areas are completely segregated from the administrative area. The functions are properly related to one another. There is also a proper lighting and ventilation in the administrative block. In addition, it is well landscaped. Adequate storage facilities are provided.

The walls are built of concrete blocks at the plant. The span in the storage and production hall is achieved with the steel I-sections

portal frames. Uniform spacing of the columns provide adequate transmission of loads to the foundation. The floor is made of solid concrete with cement screed finish. The roof truss is of steel covered with aluminium sheets.

### 4.2.3 **MERITS**

1- Noisy areas are completely segregated from quite areas.

2- Adequate provision of storage facilities

3- The zoning is quite functional

### 4.2.4 **DEMERITS**

1- No defined parking space for trucks loading and off-loading.

2- Routes are not defined to different parts of the building.

3- There is poor ventilation and lighting in storage and production hall.

4- There is poor drainage system in the whole site.

## 4.3.0 **CASE STUDY THREE**

## **MUNICH WASTE TREATMENT PLANT, GERMANY**

### 4.3.1 **INTRODUCTION**

The waste treatment plant is located in Munich, Germany. It is designed by Kurt Ackermann and partners, (architects based in Gundelfingen, Germany). It designed to treat and sort out the

different contents of waste generated by approximately one million inhabitants-half the city of Munich.

The plant treats about 500 tonnes of waste daily. Kurt Ackermann lavished on this project the sort of attention to which we are unaccustomed in sewage treatment plants. Its sheer size (400 x 100m), its location in a delightful valley, some ten kilometers from the urban boundary of Munich and its vertical presence demende that it be treated as an element of the landscape.

### 4.3.2 **GENERAL PLANNING AND CONSTRUCTION**

Although the plant is constrained to a very real extent by its mechanics as regards form, it is ennobled and transformed into a great monument of modern technology a rare example of conciliation between Architecture and Engineering, and moreover between industry and ecology.

Ackermann's primary aims of avoiding hierachical differences, creating an open layout conducive to teamwork and ensuring maximum entry of daylight were tackled with twin two-floor pavilions measuring 42 by 21m each containing 75 workplaces. The building also serves as a test ground for a host of new developments in thermal and solar protection. Water running through tubular steel provides heating and cooling. The roof was envisaged as a fifth façade, with sandwich elements in thickly insulated aluminium sheeting. Specially developed aluminium

frames with double separation hold the glazing and façade panels. The glass on the façade and roof is triple-layered and heat-absorbing, and contains two infrared reflecting layers and a layer of inert gas, 70% less heat being lost than with conventional double glazing.

The complex is well landscaped and maintained. Natural light and solar protection played a very important part in the design of the project. The frameless swiveling glass louvers are attached horizontally to the structure of the main façade. The basic idea of the structural frame is a free-standing "table" for the intermediate floor, with a "floating" roof construction above it. The main structural system is composed of steel Y frames at 6.80m spacing.
The industry exhibit a good maintenance culture both in the design and the choice of materials. The architect was able to control the odour generated by providing no opening in the raw material storage area. Chimneys are also provided in the production hall to release the little odour at a very high level into the atmosphere.

### 4.3.3 **MERITS**

1- The environment is well landscaped.

2- Proper anticorrosion treatment is made.

3- It is an aesthetically pleasing complex.

4- Good drainage and odour control is provided.

5- Admittance of skylight into the workshop is a good design consideration.

6- There is an adequate provision for lighting and ventilation.

### 4.3.4 **DEMERITS**

1- High maintenance cost.

2- Exposure of biostabilizer is dangerous to the environment in case of accidents.

3- It does not seem to be capitally effective.

## 4.4.0 **CASE STUDY FOUR**

## **COMPOSTING PLANT,IMPERVIA, ITALY.**

### 4.4.1 **INTRODUCTION**

The plant was established in 1987 to process and convert organic waste into compost by the Italian government. It has the ability to produce 1400 tonnes of compost daily.

### 4.4.2 **GENERAL PLANNING AND CONSTRUCTION**

The layout of the site facilitates easy movement of vehicles and pedestrians. The circulation routes are well defined. The zoning relates the production hall, administrative block and auxiliary facilities close to one another.

In the site plan, we see the distribution of distinct bodies of the industry. The prismatic volume of the building and dispatch hall are visually aligned. The administrative block is slightly curved to relate

with the site. The production and administrative blocks are detached from the workers' facilities such as restaurant and clinic.

The industry relies solely on mechanical system of odour control. In an attempt to control odour, no windows are made around the biostabiliser hall. Lighting and ventilation are achieved by mechanical means. This results in high maintenance cost and energy consumption. The building façade and the section through the different parts of the complex exhibits a good maintenance culture.

### 4.4.3 **MERITS**

1- Odour leakage around the environment is kept to a minimal.

2- Proper anticorrosion treatment is made.

3- The factory is well landscaped.

4- Good drainage system is made on the site.

5- Circulation routes are also well defined.

### 4.4.4 **DEMERITS**

1- High maintenance cost.

2- Ventilation and lighting are mechanical rather than natural

3- High energy consumption.

## 4.5.0 **CONCLUSIONS FROM CASE STUDIES**

The point mentioned in the findings of all the various case studies are important, especially the merits and demerits of the various buildings.

Design, construction details, choice of materials and services greatly affect the deteriorating capability of elements of a building. The choice of materials in the floor, foundations, roofs, surface finishes, walls and so on influence the maintenance of the complex base on its functional performance, structural, fire and safety requirements. The designer has to also understand the problems connected with maintenance in the industry so that he applies his knowledge right from the design concept.

It is also observed that well organized maintenance departments and effective maintenance policy provide excellent way to minimizing maintenance problems in buildings.

# CHAPTER FIVE

# MINIMIZING MAINTENACE PROBLEMS IN INDUSTRIAL BUILDINGS

## 5.1 Introduction

At the moment of conception, the preparation of the brief- the decision made and the parameters, established determine for good or ill, the physical characteristics, the life span and the aesthetic qualities of the final completed work.

## 5.2 Odour Generation and Control

Odour is normally generated during decomposition process. An increase in the surrounding temperature fasten the rate of decomposition in the refuse waste. This happens both at the refuse reception stage and at the sorting stage. The surrounding temperature therefore has to be low. A cool environment is necessary to avoid the early decomposition. As such a shade has to be maintained around the reception and sorting hall as a protection against solar heat penetration. The halls have to as well be oriented in regard to this. Trees, shrubs, heat insulative materials and other sun shading devices can as well be used to counter the effect.

The odour generated can also be blown up by the north-east and south-west trade winds. The wind blows up the odour towards its direction of flow. This necessitates proper orientation to control the

odour from reaching the administrative block, other public areas, and surrounding neighbourhoods.

Aside treatment with Anticorrosive chemicals, the odour movement to areas such as the administrative block and workers facilities can also be controlled by creating a buffer zone in between the areas. The use of landscaping elements like planting of trees, hedges, shrubs and other wind breakers would be used to reduce the odour movement.

## 5.3 **Building Site**

A building should be adaptable and grown out of its site for its to function effectively. Before one begins to design and construct an industrial building, one should carefully consider the implication of its proposed site. It geographical location, topography, soil type, vegetation, water presence and climatic condition should influence the over all building form, its orientation and relationship to the ground plane, its interior space design and layout, and its maintenance culture. These factors affect the structural system of the industry, its coice of materials and construction techniques.

## 5.4 **Soil**

Practically, all industrial buildings depend on soil for their ultimate support. Their structural integrity depends n the soil type and its strength under loading. A soil's strength under loading is

dependent on its resistance to shear, a function of its internal friction and cohesion. The measure of a soil's strength is its compressibility or bearing capacity in kilograms per metre square" ching ( 1975).

The drainage qualities of a soil should be taken into account to ensure that both surface and ground water is properly channeled away from the building structure to avoid deterioration of the soil load bearing capacity, possible leakage of water into a building interior and harmful effects of moisture on a building's materials.

## 5.5 **Foundation**

The foundation system of a building, a part of its substructure is a critical link in the transmission of a building load down to the ground –bearing directly. The foundation system distribute loads so that settlement of the building is either neglible or uniform under all parts of the building. "It must not break or twist under the load, disintegrate in the presence of water; sag or crack because the ground is not firm; slip because it has not been did level; crack because of large tree roots; be undermined because it has not been laid deep enough a condition known as slour" fullerton ( 1979).

The most critical factor in determining the foundation system of a building is the type and bearing capacity of the soil to which the building load are distributed. The most efficient loading and foundation system is that which transmits building loads most

directly to the soil without exceeding the bearing capacity of the soil.

Foundation design should aim at keeping differences in settlement to a minimum in order to prevent harmful distortion; the object should be able to keep movement as slight is possible. If some change is expected then foundation and structure together should be sufficiently rigid to redistribute load and keep settlement within limits.

Foundation footing should always rest on undisturbed soil. If this is not possible, the footing excavation should be filled with concrete to make up the extra depth. Footing bearing on consolidated fill or stabilized soil should be reinforced and designed by an engineer. In case of unsettled ground, wet clays, dynamic soils and ground with poor drainage pad or pile foundation can be employed.

Additional important consideration in the design of a foundation system include;

1. site topography
2. desired building form and structural system
3. foundation materials, concrete and masory
4. requirement of thermal insulation water proofing and or moisture protection, expansion and contraction.

## 5.6 **Floors**

Floor system are elemental part building occupant and content and dead loads – weight of the floor's constituent parts plus possible loading from floors and wall above. Structurally, the floor system must transfer these load laterally to either beams and column or to bearing walls, while providing at the same time material support for adjacent walls.

Floor system properly selected and designed will help in minimizing maintenance problems in industries. It must safely support moving loads, hence the floor system must be relatively stiff while maintaining its elasticity.

Floors needs to satisfy a number of functional requirements hence reducing their maintenance. There are basically two types ; ground floors and upper floors;

1. To withstand the loads that will be imposed on them
2. To prevent the growth of vegetable matters inside the building, by the provision of the concrete oversize.
3. To prevent damp penetrating the building by inserting a damp proof membrane below the floor.
4. Meet certain prescribed insulation standard; for instance, with ground floor of centrally heated building it is advisable to incorporate a layer of insulating material to reduce the heat loss into the ground below.

5. Reasonably durable and so reduce the amount of maintenance or replacement work to a minimum.
6. Provide an acceptable surface finish which meet the needs of the workers and the industry with regards to appearance comfort, safety, and easy maintenance.

**Upper Floor Requirement**

1. To support their own weight, ceiling and supper imposed load
2. To restrict the passage of fire.
3. To posses an adequate standard of durability.
4. To bridge the specific span economically and be capable of fairly quick erection.
5. To accommodate service daily.
6. To provide an acceptable surface finish in the manner described for ground floors.
7. It should easily support these finishes and reduce this maintenance.

## 5.7 **Walls**

Wall systems are building's primary vertical planar elements. They are solid structure of brick, stone, concrete, aluminum, timber, depending on its length and height. They may be bearing planes of homogenous or composite construction or they may be composed of linear bearing elements (post and columns) with non-structural

panels filling in between them. How these walls and columns support either floor or roof systems above and how they are supported in turn by walls floors or foundation systems below is determined by the structural compatibility of these systems, and the type of connection and material need.

Exterior walls serve as a protective shield against exterior conditions for the building's interior spaces. The exterior skin which may be either applied or integrated with the wall structure must be durable, resistant to wear and other elements (sun, wind and rain), depending on its orientation on the site, a wall's heat transmission properties, its reflectivity and absorptivity, and its insulation value should be an important factor in the design and choice of a wall system. The exterior wall is the point at which the control of air, moisture and water vapour flow take place hence subjected to all climatic harassment which if not properly designed will result in maintenance problems.

Interior walls and partitions may be either load-bearing or non-structural, and serve as dividers and defining elements of space, visually and acoustically, their surfaces must be durable and wear – resistance, and the desired finish, colour and texture should be compatible with the wall system used. Adequate provision should be made in order for it to accommodate the vertical and horizontal travel of mechanical and electrical lines as well as their outlet. This helps in reducing the maintenance cost

The size and location of door and window openings in walls are determined by the type of natural light, ventilation, view and access required. In addition, these openings should comply with the resistance of the wall system construction so that, structurally, vertical loads are properly distributed around the opening and ensure that stresses around the openings are not transferred to the door and window unit themselves. Also, the joint between the wall and the door or windows should be properly detailed to prevent moisture penetration.

## 5.8 **Roofs**

The roof system of an industry functions as the primary sheltering element protecting the interior spaces of the different parts of the industry from the natural elements. It also control the flow of water from rain, water vapour, heat and air. In addition, it must be structured to carry its own weight as well as live loads and wind load. The roof system should be fire-resistance and may have to accommodate mechanical and electrical equipments.

Since the roof system is a primary generator of building loads, it must be compatible with the wall and column systems through which these loads are transferred down to the foundation system.

Economy of erection and maintenance, durability, weather resistance, strength, fire-resistance, insulation, and potential heat

loss or gain should all be considered in the choice of a roof system and its materials.

The form of the roof system is a critical element in the visual image of a building whether flat and hidden by a parapet wall, or spread as a strong horizontal cap over the building mass.

## 5.9 **Doors and Windows**

Doors and windows provide for physical, visual and height penetration into and through a building's interior while enclosing interior space and maintaining the continuity of the building skin.

Doors and doorways provide means of access into the interior from the exterior and passage between interior spaces. Exterior doors must provide weather –tight seals when closed, maintain the approximate insulative value of the building's exterior wall, and minimize the possibility of condensation forming on their interior surfaces. At the same time, they must be large enough to move through easily and accommodate the moving of interior furnishings and equipments. Ease of operation privacy and security requirements, and the possible need for light, ventilation, and view must also be considered in a door's performance.

Windows provide for light, ventilation and view. As with exterior doors, windows should provide a weather tight seal when closed to avoid maintenance problems, have insulative value, and be free from condensation. There are many types and sizes of

windows, the choice of which affects not only the physical appearance of building but also the natural lighting, ventilation, and view potentials.

The size, proportion, and location of doors and windows in an industry must be carefully planned for, so that adequate rough openings with properly sized lintels can be built into the building's wall system to allow for minimum maintenance.

## 5.10 Control of Water flow on Building Surface

The architect details should have the very practical effect of breaking up concentrations of rain water and spreading the washing effect of the rain more evenly over all surfaces, thereby improving the weathering of the building envelope.

Overhanging eaves, projecting gutters and pings, strings courses and sills save industrial buildings from the worst effects of the differential weathering associated with differing quantities of water flowing over the building surfaces.

Architects must design building details which will dissipate the expected built-up of water either by casting it off the building or by diffusing the flow as evenly as possible in places where it will not affect the weather tightness of the building.

## 5.11 **Finishes**

Exterior wall surfaces must be weather resistant, thermally insulative, durable, and relatively maintenance free. Interior walls should be wear resistance, anticorrosive, and cleanable, floor finishes should be safe (non-slip), and durable against; traffic wear; ceiling should be maintenance free. All these depend on the right choice of materials applicable for effective performance.

The strength of a finish material demands on its stiffness and, or brittleness and the rigidity of its backing, whether a planer material or a network of thin framing members.

For visual appearance, all finish materials should be considered in terms of their colour, texture, scale, and their maintenance nature.

## 5.12 **Fire Safety**

Fire is special kind of oxidation known as combustion. Fire has a triangle of needs; fuel, high temperature and oxygen. If deprived of any of these needs, building fire will be extinguished more readily.

Three common objective of safety in industries in order of usual importance are:

i. Protection of life

ii. Protection of property

iii. Continuity of operation

Many of the elements of an industrial building are covered by building codes, but it is important to remember that codes specify the minimum acceptable protection. An architect can go much further than the codes required to enhance fire safety. It is also important to realize that codes cannot cover all aspects of fire safety, as there are too many variables to building design. The inadequacy of attitudes such as "leave it to the code and sprinkler system" can be seen in the list of common design deficiencies given in table 5.3, all of which can contribute to the spread of smoke and flame through and between buildings and production halls.

Table 5.3

| Design Deficiencies that can contribute to Fire spread through a building |
| --- |
| • Lack of or inadequate vertical and/or horizontal fire separations.<br>• Unprotected or inadequately protected floor and wall openings for stairs, doors, elevators, duct, conveyors, pipes and windows.<br>• Concealed spaces in walls and above ceilings without adequate fire stopping or fire divisions.<br>• Combustible structure members (beams, griders, and joists) framed into fire walls. |

- Combustible interior finish, including combustible protective coatings and insulation.
- Improper anchorage of structural members in masonry-bearing walls.

Source; fire protection handbook.

The fire safety of an industrial building depend firstly on what is done to prevent a fire from starting in the industry, and secondly on what is done through design and good management to minimize the spread of fire if and when it happens. Good design and usage is perhaps the major factor in both fire prevention and control. Once a fire has started, its spread will depend on the design of the industry, the materials used in construction, building content, method of ventilation, detection and alarm facilities and fire extinguishing system, if any.

# CHAPTER SIX

# STUDY AREA

## 6.1.0 PHYSICAL SETTING

Kano state is located in the North-central region of Nigeria, between latitudes $100.30^0$N and $120.45^0$N, and between Longitudes $70.30^0$E and $90.3^0$E. It is bordered by Jigawa State in the North, Kaduna state in the South, Katsina State in the West and Bauchi and Jigawa states to the east, Kano state has a landmass of about 20,131, square kilometer.

Kano state derived its name from the ancestor of Agbayawa (the earliest settlers) who migrated from Gaya in search of iron stone and chemical. It has a population of 5,632,040 in 1991 and now has a projected population of 7,661,450;56% of them being Male. Kano state has a gross population density of 270 persons per square kilometer ranging from as low as 82 in Tudun Wada to 856 in Ungogo and over 8000 in Kano metropolis. It has a high concentration of rural population and population density away from the metropolis. Famous landmarks in Kano include the Goron Dutse and Dala Hills.

### 6.1.1 **Geology and Soil**

More than 4/5 of Kano is underlain by quartzite undifferentiated meta-sediment and basement complex rocks of the pre-Cambrian upper Cambrian origin.

In its natural state the soil of Kano is composed of ferruginous tropical soils formed on crystalline acid rocks in about 2/5 of the state to the south, south-west and south east; brown and reddish brown soils and latosols in the northern half, brown and reddish soils in the north-east corner; and juvenile and hydro-morphic soils in the alluvial channel complexes.

### 6.1.2 **VEGETATION**

The natural vegetation of Kano consists of the Sudan and Guinea Savannah characterized by bush grassland. 4/5 of the vegetable is now farmed parkland, dotted with patches of shrub Savannah. Also found in Kano is the Savannah woodland, which is typified in Falgore Game reserve. Vegetation is green during the rainy season and yellowish brown to bright red during the dry season.

### 6.1.3 **PEOPLE AND DEVELOPMENT**

The predominant ethnic tribe found in Kano is the Hausa-Fulani tribe, followed by Yoruba and Igbo settlers. Other tribes found are the Shuwa Arabs and Labanese. Hausa is the most widely spoken

language in the state, with other languages spoken including English and pidgin. The official languages however are Hausa and English. Islam is the most predominant religion practiced; Christian however, are also found, with pockets of pagans (maguzawa).

At least 44 urban Centres exist in the state but Kano, the capital is preeminent. Kano metropolis is dominated by residential land-use divided between the old walled city (Birni), migrant Centres and new layouts. In metropolitan Kano, 34 residential, 13 commercial and 4 industrial layouts have been created.

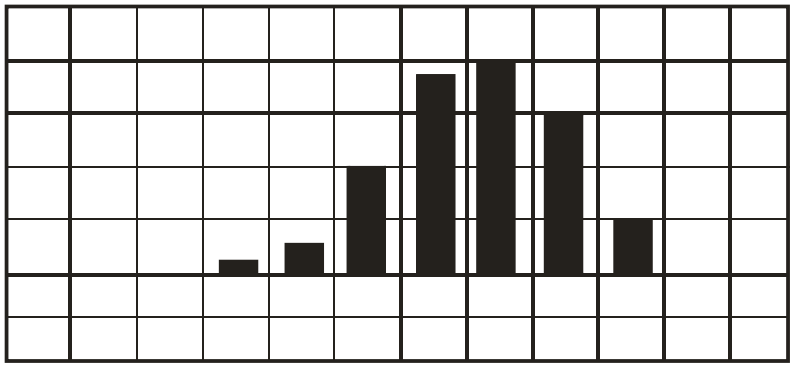
### 6.2.0 **CLIMATE**

Kano state is characterized by 4 seasons.

1. The dry, cool season (kaka) lasting from mid-November to February and characterized by cool dry weather and occasional dusty haze.
2. The dry, hot season (bazara) lasting from March to mid-May, and characterized by temperatures of up to $40^{o}$C. It is the transition period between harmattan and the wet season.
3. The wet, warm season (damina) lasting from mid-May to September
4. The dry, warm season (rani) lasting from October to mid-November, and is characterized by high humidity and high temperature.

### 6.2.1 **RAINFALL**

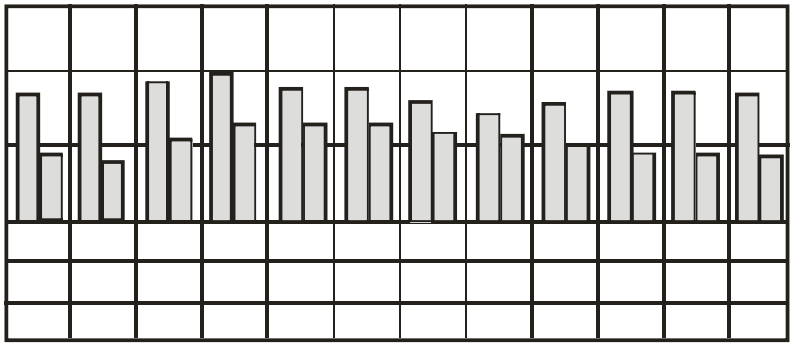
Mean annual rainfall ranges from over 1000mm in the extreme south to a little less than 800mm in the extreme north.



### 6.2.2 **TEMPERATURE**

Mean temperature ranges from 26$^{0}$C to 33$^{0}$C.

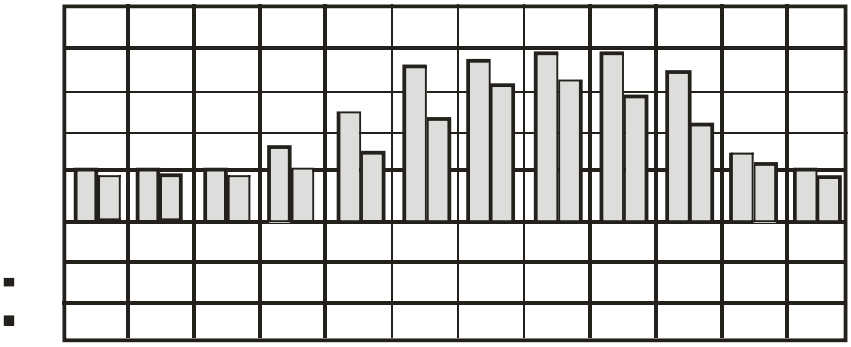
Kano Annual Temperature



### 6.2.3 **RELATIVE HUMIDITY**

Peak relative humidity ranges from 18% in March to 78% in August. Diurnal ranges can be as high as 25% in the month of June. Humidity ranges from 20-50% during the dry season to 55-95%

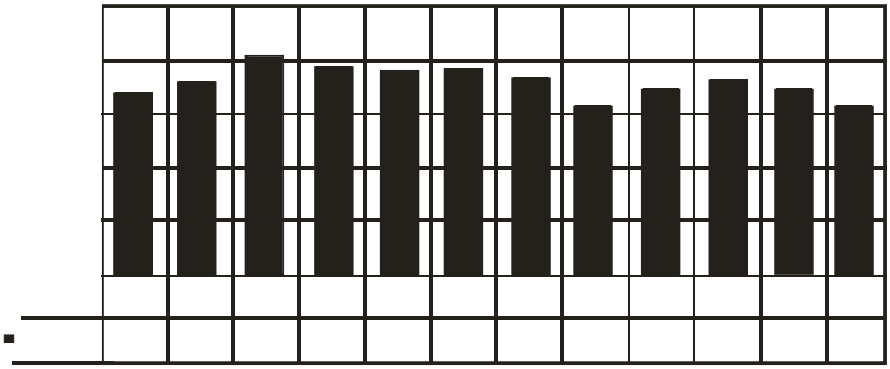
during the rains. Low humidity is characterized by dryness, cracking of lips & skin.



### 6.2.3 **SUNSHINE**

Adequate sunlight is needed for proper vision and a good psychological effect in buildings. In Kano, the highest radiation is experienced in March, while the lowest is in December.

Due to high solar intensities, which lead to high temperatures during the day, soft landscape in leaf during these critical periods can be provided near Openings to reduce the effect of solar intensity. Also hard landscape should be reduced to a minimum.



### 6.2.4 **WIND**

Two principal wind currents influence Kano.

1. The northeastern (harmattan) wind ,which is hot , dry and frequently dust-laden. Under this wind, weather is dry, generally cloudless, temperature are high in the afternoon and cold at night and in early morning. There is frequent haze with low visibility.

2.. The southwestern (monsoon) wind, which is warm and moist. Clouds are frequent with noon and evening thunderstorms. Kano come under the influence of monsoon wind as from April, and the harmattan wind as from October, when the intercontinental convergence zone moves Northward and Southward respectively. Wind velocities are at their minimum during the evenings. The strongest persistent winds are however experienced towards the end of the dry season.

### 6.3.0 **SITE SELECTION CRITERIA**

There are a vast number of factors that would influence the location of Compost Manufacturing Industry in Challawa, Kano state. These factors act together to influence the citing of the industry. These include:

a) **Economic activities**: There is a readily available market for the industry's product both in Kano state and other states in the Northern region.

In addition to the above cited market potentials, there exist need for the salvageable by the neighboring industries like plastic industries, glass industries and steel industries which use them as raw materials.

b) **Transport**: An industry should be located where there is transportation route that is easily accessible. Therefore since Challawa is linked with three major routes that linked it with Kano town and other neighbouring states. It serves a good location.

Another advantage of the site is its closeness to a running railway track station which is less than 20km from Panshekara town.

c) **Man-power resources**: The professional manpower resources available within this region are available from the country's higher institutions like Bayero University Kano, Ahmadu Bello University, Kano State Polytechnic, and so on. Where as in terms of the unskilled labour, the relative number of recorded adult inhabitants of over 40,000 in 1991 census from within Panshekara town alone is enough to cater for all of the proposed composting activities.

d) **Availability of raw materials**: Nearness to source in citing the industry is very important because of the bulk

nature of the refuse waste required by the Composting Industry.

Therefore, the site which is located near Kano metropolis will help in reducing the cost of transportation; and most importantly closer to the raw materials. Majority of the refuse waste needed will be supplied by the state government and some non governmental organisations from the refuse collection centres. Therefore, there will not be any problem in te supply even if the factory increases its production capacity.

e) **Physical features**: industrial site are best flat or gently sloping since most industrial processes are carried out on the same level flat form. Therefore, the proposed site has a flat terrain that is suitable for Compost Manufacturing activities.

f) **Power supply**: There must be an adequate supply of electricity for any industry in order to meet energy requirements.

In Challawa industrial layout there is a constant supply of electricity from NEPA. The methane released can as well be converted to electric power if need be.

g) **Government policy**: The Kano state government is committed to waste management and sanitation especially within the metropolis. Presently, it has the relevant policies

that support sustainable development on environmental issues. A well planned strategy is al it needs to activate the policy.

h) **Water supply**: Compost manufacturing industries use vast amount of water in its production process. For this reason, the proposed factory is cited close to a steady source i.e. the Challawa dam.

### 6.4.0 **THE SITE:**

The site chosen for this thesis is located in Kumbotso Local Government Area on the outskirt of Kano city within the Challawa industrial layout near Panshekara town. It is about 650m from the Kano metropolis. The site is about square meters in size.

### 6.5.0 **SITE ANALYSIS**

#### 6.5.1 **ACCESS**

The first road is linked to a road linking the industrial layout to the town. This runs along the eastern axis of the site, while the second road runs along the southern axis leading to other neighboring industries. Good access to site by both commercial and private vehicles is therefore guaranteed.

### 6.5.2 TOPOGRAPHY

The site slopes gently from the south-eastern corner to the North-Western corner towards the road. This makes for easy construction, and the minimal use of changes in level. Drainage of the site would follow the slope.

### 6.5.3 SOIL CONDITION

Laterite earth characterized the site, although the southern fringe is sandy. The soil condition should not pose any restriction to normal site work.

### 6.5.4 VEGETATION

Vegetation is characterized mainly by short grasses and small shrubs. A few trees dot the landscape of the site. Trees should be planted on the site especially along the north-eastern, axis to reduce the effects of the solar eat and wind.

### 6.5.5 UTILITIES

The site is well within service utilities. Two roads run along two sides of the site and NEPA power cables run along the southern end of the site. The site is also within the reach of pipe-borne water supply.

### 6.5.6 **SITE CONSTRAINTS**

The site is free from any landmass or man-made structure that could hinder proper utilization.

# CHAPTER SEVEN

# COMPOST PRODUCTION PROCESS

## 7.1.0 INTRODUCTION

Compost is a partially decomposed organic material used on farmlands to improve soil and enhance plant growth. Compost improves the movement of water, dissolved nutrients, and oxygen through the soil, making it easier for plant roots to absorb these vital substances.

**Definition**

Haug (1980) defined composting as the biological decomposition and stabilization of organic substrates under conditions which allow development of thermophilic temperatures as a result of biologically produced heat, with a final product sufficiently stable for storage and application to land without adverse environmental effects. Another definition, recently agreed in Europe, refers composting to a controlled aerobic process carried out by successive microbial populations combining both mesophilic and thermophilic activities, leading to the production of carbon dioxide, water, minerals and stabilized organic matter. Generally, composting is applied to solid and semi-solid organic wastes such as nightsoil, sludge, animal manures, agricultural residues, and municipal refuse.

A versatile material, compost benefits virtually any soil type. Clay soil, for example, has tiny, tightly packed particles that hamper the flow of water, nutrients, and oxygen. Compost reconfigures the clay into larger, more loosely packed particles. The larger spaces between the particles improve the flow of water, oxygen, and nutrients to roots. In addition, the roots are able to penetrate deeper into the soil and contact more nutrients. Compost also improves sandy soil, where the large spaces between loosely packed particles enable water and its dissolved nutrients to drain too quickly for optimum root absorption. Compost soaks up and holds these substances so that the roots have more time to absorb them. Compost also adds small amounts of zinc, copper, boron, and other vital nutrients to soils.

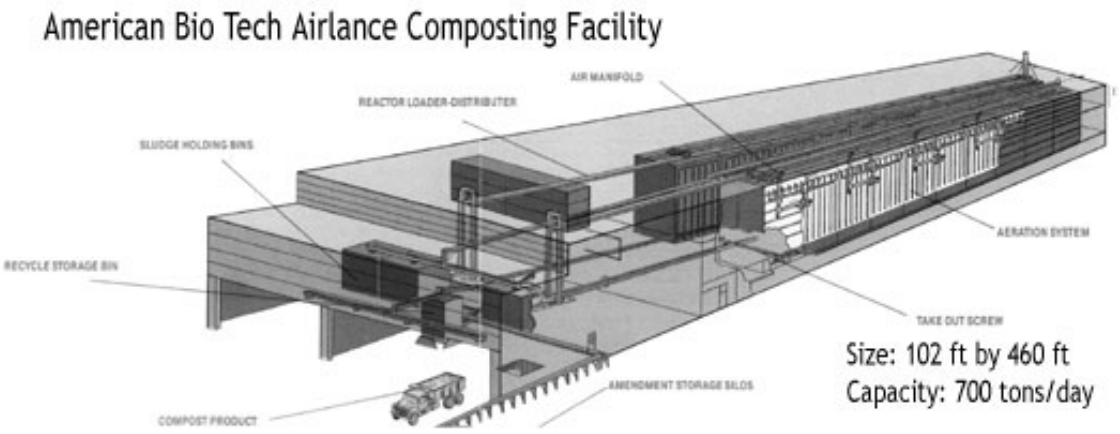



Figure 7.1 American Composting facility

### 7.2.0 **MAKING COMPOST**

The non decomposable materials like steel, glass and plastics are separated out first. The salvageable are sorted out and separated based on their physical properties using ballistic separators, heavy magnetic pulleys, BRIM classifiers, screen trowels, manual handpicking and rotary screens.



Figure 7.1 Refuse reception hall

The decomposable organic content are then collected in Hoppers and passed into the shredding machine. At this stage the waste is shredded, mixed and compacted to reduce their sizes to smaller particles thereby increasing the surface area. The shredded material is then conveyed using belts to the biostabilizer.



Figure 7.2 Biofiltering facility



Figure 7.3 Mixing facility




Figure 7.4 Turner

The biostabilizer is a cylindrical chamber tilted slightly from the horizontal usually about 3-4 meters in diameter and varying from 20-25 meters in length according to the quantity of the material to be stabilized. The cylinder rotates at up to 1rpm and air is supplied by fans at a low pressure, through longitudinal ducts, each having several injector nozzles. The above conditions enhance effective aerobic decomposition of the organic matter in the cylinder. It stay there for about a week. The composting material is then released

out for curing in an open lot for about three days prior to being packaged or used as soil conditioner. The biostabilizer harnesses the natural decomposition process carried out by certain species of microorganisms. These microorganisms, primarily bacteria and fungi, live in intimate association with their food supply—on the surface of dead plants, in soil, or on or in raw waste. By breaking down these materials with their digestive enzymes, the tiny creatures release and absorb the nutrients within.

A broad range of organic matter, including manure from plant-eating animals, grass clippings, and dead leaves or garden plants, provides a veritable feast for microorganisms. For optimal decomposition, the combined starting materials should have an appropriate carbon to nitrogen ratio, preferably 30 parts carbon to 1 part nitrogen. Leaves, straw, and paper, called brown materials, have a high carbon to nitrogen ratio, about 300 to 1, while grass clippings, kitchen scraps, and manure, called green materials, have a low carbon to nitrogen ratio, about 15 to 1. For the best mix, green materials should be added in abundance; brown materials should be used more sparingly.



Figure 7.5 Section through biostabilizer

The starting materials are heaped into a biostabilizer. On farmlands where composting is done on a smaller scale, a pile of about a meter high and a meter wide is formed. The pile may sit loose on the ground or it may be enclosed using a variety of materials, including wire fencing, wood boards, cinder blocks, or widely stacked bricks.

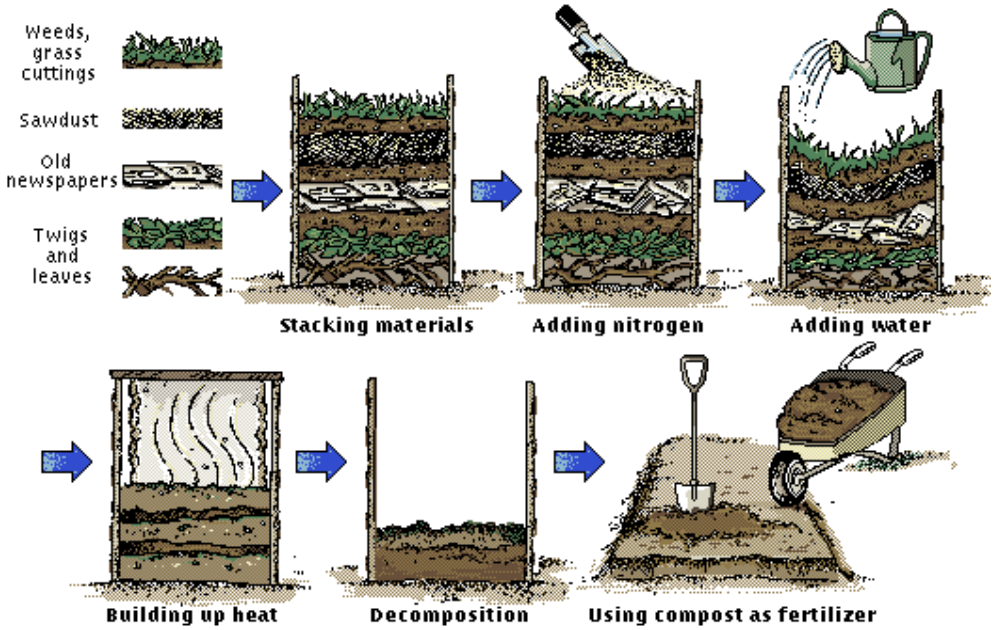



Figure 7.6 On-farm composting

### 7.3.0 **MANAGING COMPOST**

In a well-managed compost biostabilizer, the microorganisms eat and reproduce rapidly, and heat is released as a byproduct of their intense biochemical activity. The heat in the biostabiliser kills most plant diseases and weed seeds that may have been present on the starting materials. The increased heat may also kill the microorganisms doing the decomposing as well, especially those at the center of the pile where temperatures may climb to 90° C (200° F). Mixing the materials well prevents lethal temperature increases by distributing the heat evenly throughout the biostabilizer.



Figure 7.7 Section through Grinding machine

The time it takes microorganisms to decompose the starting materials in compost varies. Factors include the size of the biostabilizer, the techniques used to manage the biostabilizer , and

the nature of the starting materials—green materials decompose readily, while brown materials take longer to break down. In an actively managed compost biostabilizer , microorganisms use up their food supply and become less active after about six days. Then the biostabilizer slowly cools, signaling the near-final stages of decomposition. If the materials in a compost biostabilizer are relatively large, if the biostabilizer is not kept sufficiently moist, and if oxygen is inadequate, microorganism activity is slow and the biostabilizer does not heat up.



Figure 7.8a  Enclosed Biostabilizer



Figure 7.8b Exposed biostabilizer

No matter how long decomposition takes, when in its final stage, the composting material is about half its original size and resembles dark soil. The material is now called humus—although the terms *humus* and *compost* sometimes are used interchangeably. Humus is the highly beneficial material that is added to the soil. Once in or on the soil, it continues to decompose at a very slow rate, releasing ammonia, carbon dioxide, and salts of calcium, phosphorus, and other elements that are beneficial for plant growth.

The drying machine is used to dry up the compost after which it is taken to the laboratory for quality test and control. The dried material is then fed into the palletizing machine.



Figure 7.9 Compost drying bay



Figure 7.10 Compost warehouse

### 7.4.0 **PELLETIZATION**

A simple manually operated, pelletizing machine was fabricated and used. It is designed for preparing 32 pellets with dimensions 6.4 cm long, 2.0 cm diameter with a volume of 20.11 cm3 and each weighed 29.5 grams when dried. The freshly prepared pellets may be sun-dried and stored before use. The pellets were stable even after two years of storage under tropical humid conditions as in Ibadan. The colour of the dried pellets was dark reddish brown and can vary depending on the binding agent used in the process. The advantage of pelletization is in the reduction of weight and volume of the original composts. The

reduction in volume of the freshly made and that which was air died compost used here was 70.5 and 54.5 percent. The corresponding weight reductions for the same were 58.2 and 28.6 per cent. The pellets are then bagged in sacks for distribution and sale to farmers.

# CHAPTER EIGHT

## 8.0 DESIGN FORMULATION

## 8.1 DESIGN BRIEF

The proposed Compost Manufacturing industry, Kano is a refuse waste recycling complex which is made up of:

i. The administrative building which is subdivided to house different departments.
ii. Workers facilities which include first aid room, cafeteria, changing rooms and a cloaking room.
iii. Production halls composing of refuse sorting, shredding, grinding and processing houses.
iv. Storage areas; these include the finished goods store, raw refuse waste store and salvageable store.
v. Maintenance workshop for both electrical and mechanical works.

## 8.2 STAFF STRENGTH

The total staff strength of the factory is determined based on an understanding of its planned structure as the projected output. The proposed factory is expected to produce about 60,000 tonnes of fertilizer annually. The factory will operate two shifts. This will involve essentially the production staff. A comprehensive breakdown of the expected staff is as follows:

| **Production Area** | **Number Of Workers** |
|---|---|
| Raw material reception | 8 |
| Sorting salvageables | 7 |
| Shredding and grinding | 6 |
| Biostabilization | 4 |
| Quality Control | 4 |
| Packaging | 4 |
| Warehouse | 4 |
| | 37 x 2 (shift) |
| | = 74 |
| **Auxiliary** | |
| Generator Room | 1 |
| Scale Room | 2 |
| Security | 3 |
| | 6 x 2 (shift) |
| | =12 |
| **Administration** | |
| Reception/Waiting | 1 |
| Sales manager | 1 |
| General office | 4 |
| Personnel manager | 1 |
| Maintenance officer | 1 |
| Janitor | 1 |

| | |
|---|---|
| Managing director | 1 |
| Secretary to M.D. | 1 |
| Deputy M.D. | 1 |
| Secretary to D.M.D. | 1 |
| Accountant | 1 |
| Raw material officer | 1 |
| Engineers | 2 |
| | 17 |

**Workers Facilities**

| | |
|---|---|
| Doctor | 1 |
| Nurse | 2 |
| Cloaking Room | 1 |
| Canteen Staff | 3 |
| | 7 x 2 (shift) |
| | = 14 |

Total workers = 74+12 + 17 + 14

= 117 workers

## 8.3 SCHEDULE OF ACCOMODATION

| **Production Area** | **Floor Area** (sqm) |
|---|---|
| Raw material reception | 980 |
| Sorting Hall | 402 |
| Scrap metals (salvageable) | 42 |

| | |
|---|---|
| Plastics (salvageable) | 42 |
| Glass (salvageable) | 42 |
| Polythene (salvageable) | 42 |
| Shredding area | 90 |
| Grinding area | 60 |
| Biostabilization (4) | 720 |
| Drying area | 288 |
| Quality Control | 48 |
| Packaging | 144 |
| Warehouse | 288 |

**Administration**

| | |
|---|---|
| Reception/Waiting | 24 |
| Display area | 20 |
| Sales manager | 20 |
| General office | 25 |
| Personnel manager | 25 |
| Conference room | 30 |
| Computer room | 20 |
| Maintenance officer | 24 |
| Managing director | 25 |
| Secretary to M.D. | 12 |
| Deputy M.D. | 25 |
| Secretary to D.M.D. | 12 |

| | |
|---|---|
| Accountant | 16 |
| Raw material officer | 16 |
| Toilets (1.5 x 14) | 21 |

**Workers' Facilities**

| | |
|---|---|
| Kitchen | 36 |
| Store | 20 |
| Servery | 10 |
| Male changing room | |
| Female Changing room | |
| First aid room | 42 |
| Cloaking room | 20 |

# CHAPTER NINE

# DESIGN REPORT AND CONCLUSION

## 9.1 Design Factors And Considerations

This project, Compost manufacturing factory Kano, is designed finally to house the machinery required for the productions of compost (fertilizer) from refuse waste to the tune of about 60,000 tones annually.

In designing this factory, emphases is placed on maintenance and odour generated during the production process. The attenuation of factors such as choice of material in the design and planning enhance comfort, convenience and safety of workers and neighborhood in composing plants. Therefore in planning the factory emphases are also placed on the following factors:-

(a) Ventilation / Thermal Comfort

Excessive odour is always a serious environmental hazard in composing industries. Apart from the refuse waste odour, odour is also generated during sorting and biostabilization. The generated odour flow through openings and the building fabric. The factors that affect airflow through buildings include number and size of openings, position of openings and openings components.

To ventilate the production halls, it is best to make use of natural ventilation. The generated hot air that rises up can

be gotten rid of through the use of stack effect ventilation to allow fresh air from below to replace the hot air. This helps in reducing mechanical means.

(b) Noise/ Vibration

Noise and vibration of machines are the main sources of noise and in addition to this other sources are vehicular movement, biostabilizers, sorting machines and generator houses. Using neoprene pads will reduce the machine vibration.

All ducts and services passing through the walls have flexible connections or be insulated with absorbent materials at the place of contact with the structure. Landscaping is also used to absorb sound.

(c) Workflow in production hall

The production process must not be staggered but should be easy and functional and in a sequential order of a straight line.

For the proposed industry, it is best to have a straight production line to achieve a compact design and minimize the area of hard surface. It is also noted that the best way to achieve comfort and maintenance is to segregate/isolate certain process from the administrative block.

Planning of production hall shall be governed by ;

i. Operating nature, size, type and space required by the machines.
ii. The type of production line, which should not be disturbed by cross trafficking.
iii. The clear height and passage for workers movement and other supporting machines should be adequate.
iv. Auxiliary facilities and spaces such as laboratories, warehouses, quality control, maintenance room and generator room should be near the hall.

(d) Flooring

Generally, concrete flooring is to be used with hardcore below, although it has little resistance to acid, hence terrazzo finishing is to be adopted. The flooring should be

i. strong enough to carry machines
ii. resistance to vibration, sound, heat transfer and chemical or oil spillage.
iii. easy to couple machines and equipment
iv. made in sections for ease of replacement.
v. attractive but not slippery
vi. unaffected by changes in temperature and humidity
vii. easy to clean

(e) Citing and layout

The citing of Composing industry with respect to a city is an important factor that determines the finished good marketability, the availability of workers, easy accessibility and easy utilization of city's facilities while a good and functional layout reduces the difficulty in vehicular and pedestrian circulation, accessibility into different functional spaces and reduces the cost of construction. Other essential series includes:

i. Water: as the industry requires large quantity of water, it is therefore necessary to be located near the river or any source of water.

ii. Surface drainage: sewage disposal point is to be provided at the most convenient location while the site contours are to be utilized much for drainage purposes.

iii. Electricity: electric power supply is of paramount importance in composed processing, capacity.

iv. Transport and storage

The road network should be interconnected with ease and without any conflict in vehicular movement or obstruction due to pedestrian movement. To achieve this the position of loading bay is to be given due consideration and is best located close to the

beginning and end of the production process while making it to be sufficient enough for parking and turning for the loading vehicles. In general a trailer length is 12-15 metres, width 2.5 metres, plat form height 1.32 metres and has a turning radius of 15 metres.

The storage hall is to be enclosed and it's size should be proportional to the production capacity. Vehicular and pedestrian access should be well defined.

(e) Psychological impact

To provide the best working condition, it is necessary to control all the environmental factors that influence human performance and efficiency. Important among these factors are light, which enables workers to see quickly, accurately, comfortably, and safe.

The feeling or safety in which the workers are exposed to directly, affects their productivity. When a humane internal working condition is provided, the workers tend to feel at ease thereby increasing their efficiency.

Provision should be properly made for escape routes in time of emergency. Visual display sign, placards and controls should be fixed in places where the human eye can see danger signals fast.

(h) Social facilities

These facilities are important for the convenience and welfare of the factory's Work force, therefore they should preferably be located at a close vicinity to the reach of workers. They include:-

i. cloak rooms and changing rooms
ii. first aid room and supporting offices
iii. canteen and recreation areas
iv. conveniences (toilet)

(i) Administrative building

This refers to the administrative unit of any business, which provides management with a service of communications and a record of past transactions and operations. Therefore it should be preferably separated from the main production hall to avoid noise odour and disturbance, but it should not be too far.

(j) Future expansion

Future expansion, additions and alterations due to changes in technology must be taken into considerations. The buildings should be able to be used for new production technology.

Hard surfaces should not exceed more than the built up area and should expand outwards within the site.

## 9.2.0 DESIGN CONCEPT

### 9.2.1 Site Concept

The site concept is indeed the organization and structural arrangement adopted within the site. The site concept is based on functionality and simplicity. The functional flow was given more consideration in developing the site concept. The final layout is as a result a marriage between functionality and zoning concept to arrive at a functional and economic design.

### 9.2.2 Architectural Concept Of The Factory

In the factory design, the optimum orientation of the factory building with regard to the sun path is achieved. As much as possible solar heat effect which contributes to more odour generation is reduced along the refuse reception and processing hall. The administrative building which has the highest number users has its shorter facade aligned to the north-south cardinal points which are exposed to the sun rays and constitute the end walls of the building. Therefore the rays that will hit these facade will not be effective to the interior microclimates of offices. At the same time, solar radiation cannot penetrate the southern and northern facade openings because landscape elements such as trees

are properly positioned as sun and wind breakers to shade the openings and wall surfaces from coming in direct contact with the sun radiation.

The optional orientation for the production halls, for many reasons cannot be applied so simply over the entire plan; most importantly due to the production line; and the loading and offloading factors. However, the refuse reception and processing halls where the temperature should be low is relatively oriented along the west-east cardinal points on the longer side. This is achieved in most of the halls except the biostabilization unit where the whole process is totally enclosed. In taking care of the heat generated by the machines the halls are relatively oriented to catch the prevailing wind with the aluminum cladding used in louver like pattern to serve as wind inlets and outlets used to ensure air movement within the interior. Also attached between the production halls and the administrative block are auxiliary facilities such as the restaurant which might not be disturbed from the sun radiation.

The northern facade is least exposed to the sun radiation. In fact exposure occurs only in the early and late hours of heat period of the days, that is when angle of altitude is low and angle of declination is such that the sun rays are almost tangential to the surface of the walls. An advantage to space openings on this facade is that their illumination is always evenly distributed making them

ideal for offices and processing halls that need evenly distributed light in the interior.

However the southern facade with regard to sun factor has an additional advantage since the sun is high over the horizon during the hot season and be shaded using the roof overhangs. Moreover, with regard to prevailing winds, the spaces in the southern facade will experience airflow from the south west trade winds, while the processing halls enjoy the prevailing winds that will help in reducing heat generation.

To further enhance thermal comfort in the design, the phenomenon of having courtyard in the buildings has been employed to provide the basis for modification that can generate air movement by convection.

## 9.3 SITE ZONING

The site zoning for this factory is zoned based on three criteria. These are:

i. privacy, as it relates to security and circulation
ii. odour and noise
iii. function

i. Privacy: The site is zoned such as that areas accessible to the factory's customers and visitors (public areas) are located at the front. These areas include the administrative area and the

cafeteria. The production area is considered as a private zone, since customers are not expected there. An intermediate zone which is considered to be semi-private is the loading bay where the finished goods are located. This area is to be used by the staff and customers when necessary; since there is no direct access into the production hall. This zoning criteria enhances security as it separates the cafeteria, first aid room and administrative block from production area, thus making it easier to control the movement of customers. Zoning for privacy also gives rise to separation of vehicular access to the site, one for customers and staff and the other for refuse waste and salvageable off-loading and loading respectively.

ii. Odour and noise: These are strong factors of both comfort and safety, as such they form a major criteria for site zoning. Most of the odour in composing factories comes from the refuse reception house and biostablization area. The refuse reception house which generates the highest degree of odour is located at an area such that the two trade winds cannot blow the odour released towards the other buildings; also the chimneys placed above the biofilter are raised high above the factory. Sorting halls are placed next to the refuse reception house because of their lesser degree of odour generation. The administrative area, restaurant and other workers facilities are located further away from the odour generating areas.

The little noise in composing factories comes from the sorting house where sorting and shedding machines operate. The Biostabilization hall, the workers facilities, administrative areas, laboratories and packaging rooms also produce varying noise levels depending on the activities taking place. As such the site is zoned into noisy, semi noisy and quite zones. The sorting house which is the noisiest is located is located in the noisy zone, the biostabilization house and packaging hall in semi noisy zone thereby shielding the quite zone comprising the administrative area and the first aid room from the noisy zone.

iii. Function:

The function which is a very important part of industrial design is well taken care of as such the site is zoned in line with the production flow of composting factories, convenience for loading and off loading and in cognizance with privacy and noise. The site is zoned such that refuse waste which is the raw material comes through a seperate entrance to the reception (storage) house then to the production line. Both the administrative block and the finished product store are accessed through a separate entrance. Likewise the workers facilities are served by the same road.

## 9.4.0 **DESIGN OVERVIEW**

### 9.4.1 **Site plan**

The site plan has a simple efficient and functional layout. The buildings are arranged to provide for short and direct paths of flow of production and to minimize the amount of piping and wiring.

The building on the site are as much as possible well connected for solar radiation and wind to control odour movement and achieve maximum comfort. Possibility of future expansion of production units has been considered and also the storage facilities in case of increased production. The proposed compost manufacturing factory has a direct access from the main road leading to Challawa town. Access to the site is through two sets of gates on two sides of the site for effective maintenance, hygiene and good circulation. The weighbridge is placed almost near the loading and offloading bay to decongest traffic at the entrance. Bus taxi/customer drop off is provided at the gate outside the fence. There is sufficient parking in front of the administrative block to serve both the staff and customers. A motorcycle shed is also provided near the workers facilities.

### 9.4.2 **Planning**

In planning the units, functional flexibility was strived to be achieved. That is by planning such that the units are functionally related and spatially integrated.

The industry was grouped into three units, the administration, workers facilities and the production units.

**Administration:**

The one storey administration units has been planned with a courtyard and single banking to increase cross ventilation and illumination.

The planning keeps the customers comfort services on the ground floor and it is a noisy section. The upper floor accommodates the senior managerial personnel, thus, treated as a quieter zone. There is a staircase that serves for vertical communication.

**Workers facilities:**

The workers facilities is placed in between the administrative unit and the production hall. Facilities provided in the unit include changing rooms with showers and water closet for both males and females. The toilets are separated from the locker rooms for security and hygienic reasons. A restaurant is also provided and located in such a way that it serves both the administrative block and production staff. Clocking room is the last of this unit from which one moves into the production hall. An ample shed for bicycles / motorcycles as well as delivery bay for the kitchen are provided.

**Production area:**

The production area is sited at the rear part of the site. It is made up of several units which include the refuse reception hall, sorting hall, shredding and grinding areas, biostabilizers houses, curing and drying areas, pelletizing and bagging units, maintenance unit, warehouse, scale room and generator room.

The production hall has a frame structure. The roofing system is made from space frames supported with steel columns placed at regular intervals. The steel is properly treated wit an anticorrosive material called lumbar. The floor is made from reinforced concrete with granolithic screed over which are set ceramic tiles with corrosion resistance resin fixative. The walls are built from sand Crete blocks and finished with white ceramic tiles up to a height of 1.2 meters at the interior face to sanitize them for easy maintenance and cleaning. Service pipes are carried in under floor channels while a drainage channel covered with steel grating passes through the processing hall. The drainage channels are laid in such a way that each serves a processing line and is provided below the machine, so that all droppage will go directly into it without wetting other parts of the floor especially the circulation spaces.

The production hall is open and free from so many positions. The dirty zone (raw material hall) is placed out of the processing hall. Waste collection bins and drainage channels are provided for fast and effective removal of waste materials and water.

The quality control laboratory is provided between the production area and the warehouse. The warehouse packages and stores the dried compost fertilizer. It is stored either row on an open bay or in sacks. They are mostly packaged on demand. The warehouse and the raw material receiving section are raised to 1.2 meters to ease loading and offloading.

The auxiliary services and maintenance section are placed together but close to the production area. The sketch design drawings are shown in the appendix.

## 9.5 **CONCLUSION**

A great challenge facing the global community today is to make industrial economy more like the biosphere that is to make a closed system. This will minimize energy lost, reduce cost and environmental pollution.

Globally, the human population is growing faster than the available resources; we can no longer afford to encounter loss or waste. We must make architectural technologies available to convert the decomposable content of the refuse waste into compost fertilizer, through a well designed environment that is free from hazards, diseases infections, excess odour generation and easy to maintain. The role played by the architect is to give a functional and suitable design to give a functional and suitable design that will

house both human beings and machines in such a way that the aim of the project would be accomplished at a low maintenance cost.

Factors such as heat, poor lighting, excessive odour generation, functional relationship, slippery floors and workers' convenience among others which affects the level of comfort, safety and maintenance cost have been identified and dealt with in the design.

Heat as a major cause of odour generation is generated by machines and further compounded by solar radiation. This heat is combated in three different ways.

In the first way referred to as heat avoidance strategy, the appropriate use of insulative materials, colors, proper orientation of buildings, sun shading devices and good landscaping elements are used to control heat movement into the building.

In terms of heat, however, this is not sufficient enough to tackle it as a problem, therefore, another way called passive cooling was used, which is achieved during the planning and designing stages. Passive cooling strategies uses as much as possible natural forces of air flow and ventilation. The major strategies employed is the stack effect phenomenon and the basic principles of air flow through the buildings.

In order to further keep the temperature within the comfort and safety zone, a third way of response was in the form of mechanical equipment like extractor fans and air conditioners.

These make the design project a comfortable and safe environment for workers at a low maintenance cost.

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