AWARENESS OF CHEMICAL WASTE DISPOSAL MECHANISM AMONG SCIENCE EDUCATION STUDENT IN FEDERAL UNIVERSITY OF TECHNOLOGY MINNA NIGER STATE

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A PROJECT SUBMITTED TO DEPARTMENT OF SCIENCE EDUCATION, SCHOOL OF SCIENCE AND SCIENCES TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA-NIGERIA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF TECHNOLOGY DEGREE (B Tech) IN SCIENCE EDUCATION

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ABSTRACT

This study sought to examine the waste mechanisms in higher education institutions with specific reference to the Federal University of Technology Minna. The study utilised multi-stage random sampling design to obtain the relevant data. The sample selected for this study consists of 100 students of the Federal University of Technology, Minna, totaling to 100 individuals drawn from the campuses. A mix of stratified and simple random procedure was used to select a representative sample of students who participated in the study. Primary data were mainly obtained through field interviews were carried out through the administration of the questionnaires to the students and staff of Federal University of Technology. Secondary data was obtained from both the published and unpublished sources. Data was analysed using descriptive statistical tools. The analysis of the data enabled the researcher to come up with the following major findings: Federal University of Technology Minna has a diversified waste streams although it mainly consists of liquid and gas wastes; awareness of waste mechanisms practices at the Federal University of Technology did not translate to implementation of the practices; lack of awareness of the existing legal and institutional frameworks governing waste mechanisms by staff and students at the federal University of Technology is a major hindrance to their contribution to sustainable waste management. The study recommended that: There is need for policy frameworks within institutions of higher learning to address the various aspects of waste mechanisms; There is need for policy makers to create awareness among various stakeholders on the existence of various policies of waste management and the various interventions therein.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

One of the common features of school systems in the presence of school facilities like the laboratory. The laboratory in a wan designed for simple experiments like the test for the presence of simple sugar (carbohydrates) in food substance. There are more complex laboratory experiments that engulf more dangerous fumes and compounds that may be harzardous to human existence (Achankeng, 2003). In the university, complex vertices are undertaken in their laboratories and managed by experts called laboratory technologist who are support teaching staff.

Waste is any moveable solid object which the owner wishes to dispose if it is no longer useful to the immediate owner. Wastes are non-soluble materials ranging from municipal garbage to industrial wastes containing complex and sometimes hazardous substances. Man's activities today generate tons of thousands of refuse which are seen littered everywhere causing diverse environmental problems. This calls for urgent expertise in waste management as the importance of a healthy environment for meaningful and productive work is tied to proper waste management (Agwu, 2012). Waste is everybody's business as we all generate waste in nearly everything we do. In the past, waste was considered as a resources. This was because the waste that was generated was mainly agricultural and was bio-degradable and as such disposal was not a problem as the volume product was low and these agricultural wastes helped to enrich the soil. This is not the situation today as waste is a major problem that needs to be solved as urgently as possible rather than been considered as a resource (Akindele, 1990).

Over the years, studies have shown that rapid population growth and the growth of urban centers which followed the oil boom in the 1970s and industrialization came with a change in waste stream in Nigeria. This was as a result of increased use of goods to satisfy and meet the need of the teeming population resulting in the substantial increase in the amount of wastes generated. It is therefore important to note that waste generation and population growth work hand-in-hand.

In Nigerian towns and cities, wastes of different kinds are generated and disposed off indiscriminately causing lots of environmental and health hazards. A good example of such cities include Lagos, Kano, Calabar, Port Harcourt, Uyo, Aba, Yenagoa, etc. Bailey, (2015) noted that the issue of waste is not only familiar but assumed a global dimension in recent years causing series of environmental problems ranging from environmental degradation to pollution and imbalance, flooding, epidemics of infectious increase and decline in urban quality.

Waste can be classified into two broad categories – biodegradable waste and non-biodegradable waste. Biodegradable wastes are those wastes that can be easily decomposed by natural process ranging from food remnants to leaves from trees, cotton wool, clothes, banana peels, papers, etc. On the other hand, non-biodegradable wastes are those wastes that cannot be broken down or decomposed by natural processes. They can however be recycled or reused. Such wastes include bottles, glasses, plastics, cans and wrappings of all kinds, nylon bags, metals, needles and syringes, woods, etc. Wastes can also be classified based on their level of environmental contamination that is whether they are hazardous or non-hazardous to both man and the environment (Bartone, 2004).

The sources from which wastes are generated ranges from municipal (street sweeping, sewage treatment plants, schools etc.) to residential (flood wastes, plastics, vehicles, wood, glass etc.), industrial (demolition materials, ashes etc.) agricultural sources (spoiled food waste, pesticides, etc.).

Waste disposal can be carried out using several options but before any of these options can be adopted, three vital factors should be considered. Firstly, the physical characteristics of the locality as regards the topography of the area where waste management activities are to be carried out because waste disposal often requires a large parcel of land for an efficient operation especially of sanitary landfill is to be adopted; secondly, the character, quality and quantity of waste to be disposed of. The quantity and nature of household refuse varies greatly from region to region and thirdly, the financial allocation available as adequate budget any allocation must be available for capital outlay and running cost (Bayene, 1999). Various waste management authorities require different types of extensive refuse vehicles that cost a lot to maintain at the commencement of the operations and these vehicles do not often remain serviceable for long due to poor operation, maintenance and non-availability of spare parts.

Waste disposal in the final placement, destruction of radioactive surplus, banned pesticides and chemicals, polluted soils and drums containing hazardous materials using approved methods. Several methods exist for the disposal of solid wastes and these range from open dumping to ocean/sea dumping, sanitary land filling composting, incineration, encapsulation, underground disposal and a more systematic method of waste management that includes recycling, reuse, recovery, segregation and reduction.

Waste management is the collection, transport, processing or disposal, managing and monitoring of waste materials. The term usually relates to materials produced by human activity and the process is generally undertaken to reduce their effect on health, the environmental or aesthetics.

This research work focuses mainly on the management of waste chemical disposal techniques among laboratory technologist in Federal University of technology, Minna using the waste generated in the Federal University of Technology, Minna (Futminna) as a case study. Waste in the institution and its management can be said to be as old as the institution itself. Wastes do not only threaten the beauty and aesthetics of the institution but also the very health of its inhabitants. The intention of this research is to examine the techniques that are adopted in the management of chemical waste in Federal University of Technology, Minna.

Therefore, this study is designed to find out whether labor tech have the awareness of chemical waste disposal mechanism in Federal University of Technology, Minna Niger state.

1.2 Statement of Problem

One of the major problems man faces today is that of chemical waste disposal and management as waste is seen littered and scattered everywhere defacing the physical environment. Nobody likes to think of waste but the fact remains that waste is a pressing concern of our modern society. Over the years, the amount of the waste generated has grown steadily in part because of increasing population and more so because of changing life-styles and the increasing use of disposal materials. The challenge posed by this waste is that it is generated at a pace much faster than available means to manage it. The increasing rate at which waste is generated is 70% as compared to 30% of effective management and disposal methods (Agwu, 2012). The problem of waste management in Federal University of Technology Minna is worsened by the ever-increasing population in the institution which results in an increase in the use of the laboratory and other materials.

The smell of offensive odours cannot be taken for granted. This problem is further compounded by hawkers who dump their waste indiscriminately everywhere. The indiscriminate littering of waste in our campus has reached an alarming rate. Evidence shows that the indiscriminate disposal of waste has a multiplicity effect on the environment. This greatly degrades the environment of its aesthetics and even causes diseases. The increased use of disposable plastics, cups and polythene materials for packaging goods have given rise to new waste disposal problems. Some of these materials are non-biodegradable and when burnt gives rise to air pollution (Bailey, 2015).

The rapid growth of population in the University as people go in pursuit of higher/learning and exposure for a better tomorrow is posing a serious problem as regards waste generation. Dumping of refuse along street corners around the campus and their nearness to hostels,

offices, lecture rooms and halls and the time lag in evacuating them constitutes another serious environmental health hazard in the study area. These refuse dumps serve as home for vermins such as flies, mosquitoes, cockroaches and other vectors of infectious disease (Blaser and Schluep, 2012).

One of the greatest problems facing humanity today is that of waste management. In all cities and rural areas, waste disposed poses the greatest environmental problem. The rate in which waste is generated, surpasses the rate at which it is evacuated. Upon this premises, one tends to wonder what could actually be responsible for this environmentally unfriendly character. Is it the orientation or the psychology of the people lack of central waste dumps or is it a deliberate attempt of polluting the environment or perhaps the various authorities responsible for waste disposal cannot cope with the volume of waste been generated?

Another problem of chemical waste management is the diversity of the waste being generated which results in a variety of potential health and welfare effects, the treatment of which is complicated by the fact that each type of waste often demands specific and yet different methods of disposal and management. Waste is an age-mate of mankind and part of the normal working system of man's activity on the face of the earth. Though it is an integral constituent of all human activity, its presence today is becoming unbearable causing serious problems in the environment (Ekere and Mugisha, 2009). Waste in ancient times was biodegradable and non-toxic and could hardly cause hazards. Today, copious waste generation pollutes many quarters even in rural areas. Every facet of man's endeavor now face the danger of reckless throw-away; he wastes food, clothes, money, time, shoes, utensils, furniture, paper, machines, metals etc. It has now come to a point where solid waste stands face to face and side by side with man. The reason is man's technology to master and conquer his world (environment).

1.3 Aim and Objectives of the study

The main aim of this work is to determine awareness of management of waste chemical disposal techniques among science education student

in Federal University of Technology, Minna. To guide the research, the following specific objectives were stipulated.

i. To determine whether the science education students have the awareness level of laboratory waste disposal mechanisms.
ii. To examine whether male and female students have the same awareness level of laboratory waste disposal mechanisms.
iii. To find out how often these laboratory waste generated disposed off in Federal University of Technology.
iv. To find out whether there are incinerators for proper waste disposal in the Federal University of Technology.
v. To determine whether the chemical waste generated are severely harmful to handle.

1.4 Research questions

1. Do science education student have the awareness of laboratory waste disposal mechanisms?
2. Do male and female students have the same awareness level of laboratory waste disposal mechanisms?
3. How often do laboratory waste generated disposed off?
4. Are there incinerators in the university for laboratory waste management?
5. Are the laboratory waste generated in the university severely harmful?

1.5 Significance of the Study

Sequel to recent trends in the demand for the useful information as regards Chemical disposal waste management, this research comes as an information pack that will be very useful to the general public as well as the authorities of the Federal University of Technology, Minna as the problems of waste generation and management roots itself to everybody.

This research will be of immense benefit to the environmental sanitation and protection unit of the Federal University of Technology, Minna, researchers and policy makers who may wish to carryout more research on the same problem.

1.6 Study area

This study was carried out in Federal University of Technology, Minna. Established in 1982, Federal University of Technology, Minna is a non-profit public higher education institution located in the suburban setting of the small city of Minna (population range of 250,000-499,999 inhabitants), Niger.

1.6.1 Location

Federal University of Technology in located in Bosso Local government of Niger State, Federal University of Technology is positioned at Latitude: $9^0$39'24.98" and longitude Longitude: $6^0$31'42.12" of the equator.

1.6.2 Climate and Vegetation

The study area experiences two distinct seasons, the dry and wet seasons. It has an average annual rain fall of about 1,400mm. The duration of the rainy season ranges from 150 – 210 days or more. Main temperature remains high throughout the year, hovering about 32^0F, particularly in March and June. However, the lowest minimum temperatures occur usually between December and January when most parts of the State come under the influence of tropical continental air mass which blows from the north. Dry season in Niger State commence in October.

1.6.3 Population

This institution has also branch campuses in the following location(s): Bosso. Officially accredited and/or recognized by the National Universities Commission, Nigeria, Federal University of Technology, Minna (FUT Minna) is a large (uniRank enrollment range: 15,000-19,999 students) coeducational higher education institution.

1.6.3 Socio-economic activities

Most of the staff of the institution are civil servants since the institution is owned by the Federal Government. Varieties of businesses take place within the school which generates income for both the school, government and other individuals. Some of these businesses include the school business centre, pure water factory, bakery, commercial stores around the hostels and staff quarters, open spaces within the campus where writing materials (pens, pencils, books, erasers, etc) and other items are being sold such as pure water, biscuit, soft drinks etc. Also there are bus drivers who convey students from one point within the campus to the other. All these activities take place within the campus and generated income for the school because these business men and women pay some amount of money to the school for the space in which they ate given to run their business.

All these activities produce large amounts of waste daily and will help to provide useful data in the course of this research.

CHAPTER TWO

2.0 Literature Review

2.1 Introduction

This chapter provides a summary of the literature review for the study. The review is organized thematically as per the objectives of the study. Hence, the literature review focuses on waste management practices, and the legal and policy frameworks governing waste management. The emerging gaps from the literature review are discussed.

Over the years, much literature has been devoted to the problem of waste generation, its disposal methods and its management techniques both in developing and developed countries. Recently in Nigeria, these have become a major issue of concern to both government and individuals.

There are today many features of social waste management and disposal on our radio, television and newspapers in form of debates, talks, suggestion and enlightenment programmes.

2.2 Conceptual framework

Waste is defined by the United States Environmental Protection Agency as “useless, unwanted or discarded material with insufficient liquid content to be free flowing”. Folz (2004) defined solid waste as man’s unwanted material that cannot flow directly into streams or rise immediately into the air. Gakungu (2012) define solid waste as any superfluous or rejected solid material consisting of garbage, rubbish, ashes, street sweeping, dead animals, abandoned automobiles, industrial wastes, demolition and construction materials, agricultural waste and mining industrial waste that do not decompose.

Waste are the non-liquid, non-gaseous residue of our manufacturing, construction, cooking, recreation, agriculture and other activities that are been used and discarded. They

are found anywhere man is found from marines, to stores, homes, offices, factories, hospitals, streets, and even the primitive camps of traditional nomads (Ekere and Mugisha, 2009).

The problem of waste is as old as the first man on earth and the history of disposal can be traced to the early man as he gathered for his sustenance from farming and hunting and discarded the unwanted materials from his everyday routine which resulted in building up of filth (Bartone, 2004). According to Akindele, (1990), we are suffering from the mistakes of decades that until recently we have hardly seemed to notice what Bartone (2004) views as "new ways of solving old problems".

2.3 Awareness of waste management techniques

There are numerous problems associated with waste management in Nigeria. This is despite the fact that there are a several policy and legal frameworks governing waste management. It is apparent that the challenge may lie in the awareness and enforcement of the policy.

A building block to successful waste management program is Knowledge/awareness on waste streams. This awareness will provide an effective waste reduction strategy that target most promising and problematic waste materials. While investigating management of waste in Nigeria, Bayene, (1999) found that environmental health does not only depend on rising public awareness and on the creation of mechanism of controlling generation of waste at the source but also, sharing of responsibilities between the public, institutions, private sector, non- governmental organizations and the government. The above argument is internally consistent with Chukwunonye, (2015) who argued that if responsibilities are shared social stigma on waste disposal could be mitigated.

2.4 Characterization of Waste

Waste must be categorized as to its identity, constituents, and hazards so that it may be safely handled and managed. Categorization is necessary to determine a waste's regulatory status, hazardous waste ID number, and treatability group, and to determine its proper U.S. Department of Transportation (DOT) shipping name, and to meet other transport, treatment, and disposal requirements (Gakungu, 2012).

The great variety of laboratory waste makes waste categorization challenging. Transport and waste regulations are written for commercially available high-volume chemicals, which may make it difficult to categorize some laboratory chemicals, such as experimental or newly synthesized materials. Categorization procedures must account for the common laboratory waste management practices of placing small containers of waste chemicals into a larger over pack drum, and combining of many solvents and solutes into a single drum of flammable liquids (Agwu, 2012).

There are several acceptable information sources for waste characterization, including the identity of the source or raw materials, in-laboratory test procedures (such as those described below), and analysis by an environmental laboratory. Generator knowledge can be used for waste characterization, such as the knowledge of waste characteristics and constituents by laboratory personnel who conducted the process, procedure, or experiment.

2.4.1 Characterization for Off-Site Management

When waste is to be shipped off-site for recycling, reclamation, treatment, or disposal, the waste characterization information needed depends on the waste management facility's requirements and its permit. Analytical methods have been established by the U.S. Environmental Protection Agency (EPA), and environmental laboratories that use EPA

methods are often certified or accredited. Most of these methods are for commercially available chemicals, and so approved analytical procedures may not be available for some laboratory chemicals. It is important to work with your waste disposal firm to determine how laboratory waste is to be categorized. To avoid redundant analysis for recurring waste streams (e.g., chlorinated solvents, lab packs of organic solids), waste disposal firms and off-site facilities often establish a waste-stream profile. In some cases, detailed analytical information is not necessary if waste containers fall within the profile's hazard classification (Guerrero *et al.,* 2013).

2.4.2 Identification Responsibilities of All Laboratory Personnel

Because proper management and disposal of laboratory waste requires information about its properties, it is very important that laboratory personnel accurately and completely identify and clearly label all chemical and waste containers in their laboratory, as well as maintain the integrity of source material labels. It is recommended that supplementary information be kept in a separate, readily available record (e.g., laboratory information system, lab notebook), especially for very small containers or collections. In academic laboratories where student turnover is frequent, identification is particularly important for the materials used or generated. This practice is as important for small quantities as it is for large quantities (Guerrero *et al.,* 2013).

2.4.3 Characterization of Unknowns

Establishing the hazardous characteristics and evaluating the potential listing of clearly identified waste is usually quite simple. Unidentified materials (unknowns) present a problem, however, because recycling, treatment, and disposal facilities need to know

characteristics and hazards to manage waste safely. All chemicals must be characterized sufficiently for safe transportation off-site (Guerrero *et al.,* 2013).

Analysis of laboratory unknowns is expensive, especially if EPA methods must be used, or the presence of a constituent must be ruled out, and handling unknowns is risky due to the possible presence of unstable, reactive, or highly toxic chemicals or byproducts. Although expensive, some waste disposal firms offer on-site services to categorize unknown laboratory waste to prepare it for shipment to their treatment facility.

2.4.4 In-Laboratory Test Procedures for Unknowns

When the identity of the material is not known, simple in-laboratory test procedures can be carried out to determine the hazard class into which the material should be categorized. Because the generator may be able to supply some general information, it may be beneficial to carry out the test procedures before the materials are removed from the laboratory. Perform these tests only if they can be done safely, and only if they facilitate the characterization of the waste required by your hazardous waste disposal firm. Understand that the following test procedures are only to provide additional information, and do not meet EPA regulatory requirements for waste analysis.

In general, precisely determining the molecular structure of the unknown material is not necessary. Hazard classification usually satisfies the regulatory requirements and those of the treatment disposal facility. However, it is important to establish which analytical data are required by the disposal facility (Guerrero *et al.,* 2013).

Trained laboratory personnel who carry out the analytical procedures should be familiar with the characteristics of the waste and any necessary precautions. Because the hazards of the materials being tested are unknown, the use of proper personal protection and safety

devices such as chemical hoods and shields is imperative. Older samples are particularly dangerous because they may have changed in composition, for example, through the formation of peroxides (Folz, 2004).

2.5 Collection and Storage of Waste

2.5.1 Accumulation of Waste at the Location of Generation

Laboratory experiments generate a great variety of waste, including used disposable laboratory ware, filter media and similar materials, aqueous solutions, and hazardous and nonhazardous chemicals. As stated in the introduction to this chapter, begin no activity unless a plan for disposal of all waste, hazardous and nonhazardous, has been formulated.

The accumulation and temporary storage of waste in the laboratory is called satellite accumulation. The legal standards for satellite accumulation are included in this section; they are also good practices for the management of non-regulated waste (Akindele, 1990).

To ensure security and management oversight, chemical waste should be accumulated at or near the point of generation, and under control of laboratory personnel. Note that there is an optional alternative federal standard for the accumulation of waste within laboratories of colleges, universities, teaching hospitals, and certain nonprofit research facilities associated with colleges or universities. Each category of waste has certain precautions and appropriate disposal methods. Below is a list of requirements and good practices for accumulating chemical waste in the laboratory:

- Collect hazardous or flammable waste solvents in an appropriate container pending transfer to the institution's central facility or satellite site for chemical waste handling or pickup by

commercial disposal firm. Often, different kinds of waste are accumulated within a common container.

- Take care not to mix incompatible waste. This is a special concern with commingled waste solvents, which must be chemically compatible to ensure that heat generation, gas evolution, or another reaction does not occur. For example, waste solvents can usually be mixed for disposal, with due regard for the compatibility of the components.
- Keep wastes segregated by how they will be managed. For example, because non halogenated solvents are more suitable for fuel blending, many laboratories collect halogenated and non-halogenated solvent wastes separately.
- Collect waste in dependable containers that are compatible with their contents. Keep containers closed except when adding or subtracting waste. Separate containers of incompatible materials physically or otherwise stored in a protective manner.
- Use an appropriate container for the collection of liquid waste. Glass bottles are impervious to most chemicals but present a breakage hazard, and narrow-neck bottles are difficult to empty. The use of plastic (e.g., polyethylene jerry cans) or metal (galvanized or stainless steel) safety containers for the collection of liquid waste is strongly encouraged. Note that fame arresters in safety containers can easily become plugged if there is sediment and may need to be cleaned occasionally. Do not store amines or corrosive materials in metal containers.
- Do not use galvanized steel safety cans for halogenated waste solvents because they tend to corrode and leak.
- As detailed below, clearly and securely label waste containers with their contents.

- Securely cap waste containers when not in immediate use. To minimize releases to the atmosphere, when a funnel is used either immediately reclose the container or use a capped waste funnel. Do not use the same funnel for containers containing incompatible waste types.

- Collect aqueous waste separately from organic solvent waste. Some laboratories may be served by a wastewater treatment facility that allows the disposal of aqueous waste to the sanitary sewer if it falls within a narrow range of acceptable waste types. Thus, solutions of nonhazardous salts or water-miscible organic materials may be acceptable in some localities. Solutions containing flammable or hazardous waste, even if water-miscible, are almost never allowed, and water-immiscible substances must never be put down the drain. Collect aqueous waste for non-sewer disposal in a container selected for resistance to corrosion. Do not use glass for aqueous waste if there is danger of freezing. Depending on the requirements of the disposal facility, adjustment of the pH of aqueous waste may be required. Such adjustment requires consideration of the possible consequences of the neutralization reaction that might take place: gas evolution, heat generation, or precipitation.

- Place solid chemical waste, such as reaction byproducts or contaminated filter or chromatography media, in an appropriately labeled container to await disposal or pickup. Segregate unwanted reagents for disposal in their original containers, if possible. If original containers are used, labels should be intact and fully legible. Make every effort to use, share, or recycle unwanted reagents rather than commit them to disposal.

- Consider how to dispose of nonhazardous solid waste in laboratory trash or segregate it for recycling. Check the laboratory chemical safety summary, material safety data sheet, or

other appropriate reference to determine toxicity. Consult institutional policy on nonhazardous solid waste disposal.

2.5.2 Accumulation of Waste in a Central Area

The central accumulation area is an important component in the organization's chemical management plan. In addition to being the primary location where waste management occurs, it may also be the location where excess chemicals are held for possible redistribution. Along with the laboratory, the central accumulation area is often where hazard reduction of waste takes place through allowable on-site treatment processes.

The central accumulation area is often the appropriate place to accomplish considerable cost savings by commingling (i.e., combining) similar waste materials. This is the process where compatible wastes from various sources are combined prior to disposal. Commingling is particularly suitable for waste solvents because disposal of liquid in a 55-gal drum is generally much less expensive than disposal of the same volume of liquid in small containers (Bayene, 1999). Because mixing waste requires transfer of waste between containers, the identity of all materials must be known and their compatibility understood. Although these procedures are very cost-effective, they require additional safety precautions, including the use of personal protective equipment and special and engineering controls. In addition to the facility needs described below, commingling areas require non-explosive electrical systems, grounding and bonding between floors and containers, non-sparking conductive floors and containers, and specialized ventilation systems. A walk-in fume hood is often used for both solvent commingling and the storage of commingling equipment. It is important to design the process to minimize lifting, awkward procedures that may cause injury, and the handling of heavy drums and equipment (Guerrero *et al.*, 2013).

Final preparations for off-site disposal usually occur at the central accumulation area. Decisions on disposal options are best made here as larger quantities of waste are gathered. Identification of unknown materials not carried out within the laboratory must be completed at this point because unidentified waste cannot be shipped to a disposal site.

2.5.3 Special Regulations for Laboratories at Academic Institutions

Although laboratories are generally required to comply with the same regulations as industrial facilities, regulations promulgated in 2008 provide limited relief for academic institutions from some of the requirements associated with on-site management. When adopted by the state in which the laboratory is located, these alternative standards are available to colleges, universities, teaching hospitals, and certain nonprofit research facilities associated with colleges or universities (Bailey, 2015). These standards are completely optional, at the discretion of the educational or research institution. To take advantage of these provisions, academic facilities must implement a performance-oriented laboratory management plan. This facility-specific plan must provide for seven required elements:

1. labeling standards,
2. container standards,
3. training requirements,
4. removal frequency of unwanted chemicals,
5. hazardous waste determinations,
6. laboratory cleanouts, and
7. prevention of emergencies.

The provisions allow academic facilities additional time to move waste from laboratories to central accumulation areas and additional time and flexibility in making waste determinations, and encourage laboratory cleanouts by providing relief from some time limits and generator classification provisions. However, these alternative standards require semiannual removal of all laboratory hazardous waste, whereas the standard satellite accumulation rule has no time limit for the accumulation of laboratory waste in unfilled containers smaller than 55 gal.

2.5.5 Disposal of Nonhazardous and Non-regulated Waste

Some non-regulated laboratory waste is hazardous and should be safely managed. There are more waste management options for non-regulated waste, especially with regard to hazard reduction procedures.

Some laboratories have policies that require all chemical waste to be handled as if it were regulated as hazardous. This recognizes the potential liabilities associated with misperceptions or the improper handling of non-regulated as well as regulated waste. For example, a trash hauler or landfill operator may become alarmed by a laboratory chemical container, even if it contains sucrose. Note that if different types of waste are comingled, though, then the mixture must be treated as hazardous waste, and the cost for disposal of the nonhazardous portion may increase. Also consider the possibility that a hazardous material may be improperly labeled or described as nonhazardous (Agwu 2012).

When safe and allowed by regulation, disposal of nonhazardous waste via the normal trash or sewer can substantially reduce disposal costs. Many state and local regulations restrict or prohibit the disposal of waste in municipal landfills or sewer systems, and so it is wise to check the rules and requirements of the local solid waste management authority and develop a list of materials that can be disposed of safely and legally in the normal trash. The common wastes

usually not regulated as hazardous include certain salts (e.g., potassium chloride and sodium carbonate), many biochemical, nutrients, and natural products (e.g., sugars and amino acids), and inert materials used in a laboratory (e.g., noncontaminated chromatography resins and gels). In some places, the laboratory's hazardous waste disposal firm may assist with disposal of nonregulated materials (Achankeng, 2003).

2.6.1 Disposal in the Sanitary Sewer

Disposal in the sewer system (down the drain) had been a common method of waste disposal until recent years. However, environmental concerns, the viability of publicly owned treatment works, and a changing disposal culture have changed that custom markedly. In fact, many industrial and academic laboratory facilities have completely eliminated sewer disposal. Most sewer disposal is controlled locally, Yet, if permitted by the sewer facility, it is often reasonable to consider disposal of some chemical waste materials in the sanitary sewer. These include substances that are water-soluble and those that do not violate the federal prohibitions on disposal of waste materials that interfere with pose a hazard.

Chemicals that may be permissible for sewer disposal include aqueous solutions that readily biodegrade and low-toxicity solutions of inorganic substances. When allowed by law, liquid laboratory wastes that are commonly disposed of in the sanitary sewer include spent buffer solutions, neutralized mineral acids and caustics, and very dilute aqueous solutions of water-soluble organic solvents (e.g., methanol, ethanol). After checking with authorities, some laboratories flush small amounts of water-soluble nontoxic solids into the sanitary sewer with excess water. Examples of potentially sewer-disposable solids include sodium or potassium chloride, nutrients, and other chemicals generally regarded as safe. Disposal of water-miscible flammable liquids in the sewer system is usually severely limited. Water-immiscible chemicals should never go down the drain.

In general, if laboratory wastes are discharged via a sanitary sewer, follow the advice above to contact and notification requirements and effluent limits. If not, contact your state water pollution control office to determine permitting and notification requirements and effluent limits (Guerrero *et al.*, 2013).

Waste approved for drain disposal should be disposed of only in drains that flow, never into a storm drain or septic system. Waste should be flushed with at least a 100-fold excess of water, and the facility's wastewater effluent should be checked periodically to ensure that concentration limits are not being exceeded.

2.6.2 Release to the Atmosphere

The release of vapors to the atmosphere, via, for example, open evaporation or laboratory chemical hood effluent, is not an acceptable disposal method. Apparatus for operations expected to release vapors should be equipped with appropriate trapping devices. Although laboratory emissions are not considered a major source under the Clean Air Act, deliberate disposal of materials via evaporation of vapors is strictly prohibited (Chukwunonye, 2015).

Chemical hoods, the most common source of laboratory releases to the atmosphere, are designed as safety devices to transport vapors away from laboratory personnel, not as a routine means for volatile waste disposal. Units containing absorbent filters have been introduced into some laboratories, but have limited absorbing capacity. Redirection of hood vapors to a common trapping device can completely eliminate discharge into the atmosphere.

2.6.3 Incineration

Incineration is the most common disposal method for laboratory wastes. Incineration is normally performed in rotary kilns at high temperatures (1200–1400 °F). This technology

provides for complete destruction of most organic materials and significantly reduces the volume of residual material which must be disposed of by landfill. However, it is an expensive option, generally requiring the use of significant volumes of fuel to generate the required temperatures. Also, some materials, such as mercury and mercury salts, may not be incinerated because of regulations and limitations of the destruction capability.

CHAPTER THREE

3.0 Research Methodology

This chapter contains a series of steps in a logical sequence to arrive at the aim and objectives of this research. Methodology involves all the processes in acquisition of data, the source where the data are acquired, the type of date and methods by which these data are being analyzed, in order to obtain relevant information on waste chemical disposal techniques among laboratory technologist in Federal University of technology, Minna. To achieve this aim, data were collected from two sources; Primary and Secondary sources of data.

3.1 Research design

The research methods adopted in the course of this research are historical, descriptive and observatory. The historical research method is used while searching for the historical background of the study area. General over view of the topic (research topic) and also paves to arriving to the literature review. Primary Data were collected from direct observation and from questionnaires 100 respondents were randomly and used for the study

3.2. population of the study

the population of the study are all science education students in the department of science education, school of science and technology education, federal university minna, Niger state who are numbering 3,698, the target population are 260 final year student of 2018/2019 academic session.

3.3 sample and Sampling Technique

Random stratified sampling was employed to obtain a reasonable sample size for administering questionnaires. I opted to use to use a sample size of 100 due to financial and time constraints.

3.4 Instrument for data collection

1. Structuring of questionnaires.

2. Take a visit to the study area

3. Administration of questionnaires.

3.5 Procedure for data analysis

The data collected from the field using questionnaires, interviews and observation were computed and organized into categories. The data was presented in an organized format to allow for in depth analysis. The data was presented in form of explanatory texts, tables. The data collected was analyzed using descriptive tools.

3.6 validation of research instrument

content validation of research instrument was done by my project supervisor and another lecturer from the department of science education to ascertain the degree at which items are able to effectively provide answers to the research questions asked.

3.7 data collection and analysis

Data for this study was connected through the administration of questionnaires which were accessed on the spot by respondent and collected immediately so as to avoid any incidence of possible misplacement.

3.8 Methods of Data Analysis

Data obtained on the field was analyzed via descriptive method. The descriptive was through the use of frequency table.

The collected data was analyzed using statistical package for social sciences Education 2100 version at 05 significance level to obtain the mean, correlation coefficient and T-test statistics.

CHAPTER FOUR

4.0 Result and discussion

4.1 Analysis of Data Collected

The data collected were analyzed under the following headings:

4.2 Analysis of Research Questions

4.2.1: Do Science Education Students have the awareness on Laboratory Waste Disposal Mechanisms?

Table 4.1: Analysis of awareness level of science education students on LWDM

S/N	Statements	Mean X	Standard Deviation SD	Remarks
1	Laboratory waste products can be harmful to human health	2.70	0.56	HA
2	Laboratory waste product must be properly disposed off	2.60	0.63	HA
3	Chemical fumes or gases can cause cancer and incurable ailments	2.70	0.61	HA
4	Laboratory waste products can be harmful to soil micro-organisms	2.63	0.54	HA
5	Laboratory waste products can cause air pollution	2.75	0.54	HA
6	Hazardous waste from the laboratory can be harmful and causes contaminations	2.73	0.55	HA
7	Laboratory waste products also impact on animal and marine life	2.68	0.53	HA
8	Laboratory waste product can cause extreme climate change	2.58	0.64	HA
9	Laboratory harmful substances is gradually destroying the ecosystem	2.58	0.59	HA
10	Laboratory waste mechanisms education should be giving to students and lecturers	2.73	0.45	HA

***HA: Have Awareness**

Table 4.1: shows the means and standard deviations of awareness level of science education students on laboratory waste disposal mechanisms in federal university of technology minna the results shows that respondents have the awareness on all the items / statements in the questioner with the highest mean of 2.75. this meant that, science education students have the awareness on laboratory waste disposal mechanisms.

4.2.2: Do Male and Female students have the same awareness levels on Laboratory Waste Disposal Mechanisms?

Table 4.2: Analysis on Gender

S/N	Statement	Male X	Male SD	Female X	Female SD	Total X	SD	Remarks
1	**Laboratory waste products can be harmful to human health**	**2.73**	**0.45**	**2.64**	**0.75**	**2.70**	**0.56**	**HA**
2	**Laboratory waste product must be properly disposed off**	**2.56**	**0.64**	**2.64**	**0.63**	**2.60**	**0.63**	**HA**
3	**Chemical fumes or gases can cause cancer and incurable ailments**	**2.65**	**0.63**	**2.79**	**0.56**	**2.70**	**0.61**	**HA**
4	**Laboratory waste products can be harmful to soil micro-organisms**	**2.73**	**0.53**	**2.43**	**0.51**	**2.63**	**0.54**	**HA**
5	**Laboratory waste products can cause air pollution**	**2.77**	**0.51**	**2.71**	**0.61**	**2.75**	**0.54**	**HA**
6	**Hazardous waste from the laboratory can be harmful and causes contaminations**	**2.62**	**0.63**	**2.93**	**0.27**	**2.72**	**0.55**	**HA**
7	**Laboratory waste products also impact on animal and marine life**	**2.65**	**0.56**	**2.71**	**0.47**	**2.67**	**0.52**	**HA**
8	**Laboratory waste product can cause extreme climate change**	**2.62**	**0.57**	**2.50**	**0.76**	**2.57**	**0.63**	**HA**
9	**Laboratory harmful substances is gradually destroying the ecosystem**	**2.69**	**0.55**	**2.36**	**0.63**	**2.58**	**0.59**	**HA**
10	**Laboratory waste mechanisms education should be giving to students and lecturers**	**2.77**	**0.43**	**2.64**	**0.50**	**2.72**	**0.45**	**HA**

***HA: Have Awareness**

Table 4.2 shows that analysis of awareness of science education student on laboratory waste disposal mechanism. The result shows that both male and female student have the awareness of laboratory waste disposal mechanisms in the university with the highest mean (x) score of 2.77 for male and 2.93 for female student. This mean both male and female have the same awareness on the laboratory waste mechanisms in the university.

4.2.3: How often is Laboratory Waste generated disposed off?

Table 4.3: Frequencies of Laboratory Waste Disposed

S/N	Duration	Frequencies (Freq)	Percentage %
1	Everyday	23	57.5
2	Weekly	10	25.0
3	Monthly	4	10.0
4	Never	3	7.5
	Total	40	100%

Table 4.3: shows the frequency of laboratory waste disposal in the university. The result shows that, respondents have agreed on daily laboratory waste disposal with a frequency of 23 [57.5%]. This meant that laboratory waste disposal is carried out on daily basis in the university.

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4.2.4: Are there Incinerators in the University for Laboratory Waste Management?

Table 4.4: Availability of incinerators in the university.

Response	Frequencies	Percentages
Yes	**15**	**37.5%**
No	**23**	**57.5%**

Table 4.4: shows that there are no adequate number of incinerators for waste treatment in the university with a response rate of 23 [57.5%]. This meant that, there are no sufficient incinerators in the university.

4.2.5: Are the Laboratory Waste generated in the University harmful?

Table 4.5: Analysis of Laboratory Waste generated

Respondent	Frequency	Percentage (%)
Yes	30	75.0
No	9	22.5
4	1	2.5
Total	40	100.0

Table 4.5: shows that the laboratory waste genetated in th university are severely harmful with the response rate of 30 [75.0] this shows that the chemical waste disposed from the laboratory are severery harmful in the university.

4.3 Discussion of finding

The result on the awareness levels of science including students on laboratory waste disposal mechanism in the university. The result shows that the science education have awareness of laboratory waste disposal mechanism with a mean (x) some of 2.75 and standard deviation of 0.554. in a study conducted by Ahmed (2005) on Environmental chemistry, pollution and waste Management in India find that, there in the need for installation and decentralization of solid waste processing units in Metropolitan cities/town and development of formal receiving industry sector in India. This study may not have directly inquired on awareness but however confirm the need for installation of waste/ pollutants conversion unit so that waste generated by converted to wealth for environmental safety.

In another by liar Ragharan, Kamath, Anies and Josephina (2013) titled awareness, Attitude and practices of school students towards household waste management, Kerala, India revealed that, the necessity of giving mass awareness to the impact of waste disposal practices from the beginning of school education committed environmental culture in the students. The study revealed awareness of e- waste disposal is lacking as such there is urgent need to rectify this gap in knowledge and practice.

Starovoytovaq and Namango (208) inn their study on solid waste management at university campus (part 4/10): perception attitudes and practices of students and renders recognized as a major-problem at the campus which is a gap between knowledge and practice. Respondents agree to generate about 0.14 to 1.4kg /day/ per student, 1.7kg / day / per- render on average. The finding of the study has helped in providing information that is of practice value to policy makers and planners, such as NEMA beyond the university boundaries. The research finding are also potentially-helpful to the local community as they highlight the need for involvement in SWM.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of findings, conclusions and recommendations for the study. These are based on the objectives and hypotheses of the study. The overall objective of this study was to examine the approaches to chemical waste mechanisms among science education students in Federal University of technology Minna, Niger state.

5.2 Summary of findings

With regard to the characteristics of waste streams in Federal University of technology Minna, a compositional analysis of chemical waste disposal established that liquid and gaseous were the most wastes generated. Gaseous wastes accounted for the highest proportion followed by liquid wastes. Solid and special wastes were not significant chemical waste.

Regarding waste management practices, it was established that a large proportion of waste was disposed of in designated waste containers and that waste segregation was not commonly practiced in the study area. It was further established that waste containers were neither sufficient nor suitably placed to serve the needs of staff and students. However, the containers were well maintained. The research findings also indicate that the main waste management practice was disposal by a designated waste collector. Other practices were burning and to a limited extent It was noted that despite awareness of recycling and reuse, these practices were not commonly practiced in the study area.

With regard to awareness of the policy and legal frameworks governing Chemical waste mechanisms in the study area, it was established that there was limited knowledge and awareness of the legal and policy frameworks governing waste disposal management. It

was also established that the study area did not have a specific policy document on waste management.

In relation to the challenges to waste management, the majority of the respondents indicated that the study area faces challenges in managing its waste. The main challenges included lack of sufficient waste containers; high volumes of waste generated; ignorance by staff and students; lack of waste segregation facilities as well as low motivation to sustainably manage waste. The respondents suggested that there is need to provide more waste containers at convenient locations in the study area. The need for awareness creation especially with regard to sustainable waste management practices of source reduction, reuse, recycling and waste segregation was underscored. It was also felt that the frequency of waste collection needs to be improved in order to address the challenge of high volumes of waste generated in the study area.

5.3 Conclusions

Based on the findings of the study, it is concluded that the study area has a satisfied waste disposal mechanism although it mainly consists of liquid and gaseous wastes. Field data was subjected to the descriptive and the results support the hypothesis that 'there is a significant difference in the waste streams generated at the Federal University of technology Minna.' It may further be concluded that awareness of chemical waste disposal mechanism practices translate to implementation of the practices. For instance, awareness of Burying and burning waste management practices did not result in the implementation of these practices. On the basis of research findings, it is also concluded that awareness of the existing legal and institutional frameworks governing waste management by staff and students is a major hindrance to their contribution to sustainable waste management. Furthermore, there is urgent need to urgently address the challenges of waste management in the study area.

5.4 Recommendations

There is need for policy frameworks within institutions of higher learning to address the various aspects of waste management.

There is need for policy makers to create awareness among various stakeholders on the existence of various policies of waste management and the various interventions therein.

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