Chapter One

Introduction

1.1 Background to the Study

The anecdotal evidences around showed the indiscriminate waste dumping in Nigeria especially in Oyo State which is one of the major public health concern. The major roads of Oyo State are often seen with a lot of waste been dumped on the pavement around the road sides. Also, the anecdotal evidences in most schools in Nigeria showed that students dumped waste indiscriminately in the classrooms and the school environments even when there is the existence of waste bin within their range. Waste can be seen as any garbage, sludge and gaseous and other discharged materials resulting from various human activities. Waste consists of discarded materials resulting from domestic and community activities and from industrial, commercial and agricultural operation. The genesis of waste generation is in concomitant with human kind. Man existence herald waste existence as mankind generates waste from virtually all facets of human activities. All human activities, be it natural or deliberate, brings about waste generation. With the progress of civilisation, the waste generated became complex in nature and difficult to manage to the extent that not only did the air get more and more polluted, with the poor management of both biodegradable and non-biodegradable solid waste[1, 2]. The increase in population and urbanisation are also largely responsible for the increase in solid waste. Recently, man has drastically altered his immediate environment through his day-to-day activities, in form of pollution, contamination or degradation[3].

Polluted environment contains the multiplication and or development of different stages in the life cycle of the parasites and pests that pose threats to life. In the markets or neighbourhood, the activities that have to do with exchange in the form of buying and selling generates wastes[4]. While the buyers, who sometimes engage in buying instant consumables, liters the environments with waste after consumption of items like foodstuffs, confectionaries, beverages as the case may be; the sellers also generate wastes through emptied packs, cans, cartons and every other form of dumps no longer of use to the seller. Waste emanating from domestic and community activities requires effective management[1]. In Nigeria, the issue of waste management practices, both in policy formulation and regulations, is persistently turbulent for successive administrations to handle[4]. Waste management is the method of disposing waste in such a way that makes it less harmful. In developing countries like Nigeria, the management of refuse has become a problem because environmental laws are not well implemented thus, making the risk of unhealthy disposal of refuse one of the major problems in such societies[5].

Heaps of refuse and garbage are common sight in state capitals and urban areas. Other problems are indiscriminate disposal of waste into rivers causing pollution and destruction of aquatic life. Governance of waste is a serious problem and the governments (Federal, State and local) have a big role to play in the management of waste in Nigeria especially in monitoring and evaluating the activities of waste in order to maintain healthy environment[4]. If waste can be properly and effectively managed through sanitary disposal, it will be a pointer to healthful environment and increase in the quality of life in the community thereby reducing the prevalence of diseases such as parasitic infections, tetanus, hookworm infestations, cholera, diarrhea, malaria, and typhoid to mention but a few[6, 7]. Nigeria in 2011

witnessed flood disaster as a result of improper disposal of refuse leading to destruction of several houses, loss of many lives lost and properties worth billions of naira were destroyed[3]. The consequence of this is that several people contacted diseases through epidemics and many died.

Solid waste management is a planned system of effectively controlling the production, storage, collection, transportation, processing and disposal or utilisation of waste in a sanitary, aesthetically, acceptable and economic manner[1]. Unfortunately, Nigerians seem to portray lukewarm attitudes towards waste management. The general deplorable and uninspiring characteristics of Nigeria cities continue to fester and appear as if there are no solutions to them[1]. It was added that most of the wastes generated are not removed, and that in spite of the citizens cleaning their immediate environment, the inability of the local government to remove the numerous heaps of refuse all over the streets highlights the very poor level of waste management in Nigerian cities.

Devoid of CCTV cameras, perpetuators of illegal waste dumping are still having field days in the act of indiscriminate dumping of wastes. In Oyo state for instance, waste are indiscriminately dumped on road pavement and on culvert, inside water channels, and into every streams of water. Mostly done under the cover of the day, offenders are difficult to apprehend as there are no effective mechanism to check the menace of indiscriminate waste disposal practices. Anecdotal evidences show that this same practice are seen being replicated by students such as pre-service teachers in Oyo town. On the part of the government, this practice has continued to linger on because there are no effective means of waste management system in Oyo state, while the government through its sister agency continue to pay lip service towards efficient sanitation exercise.

Environmental sanitation has remained an intractable problem in Nigeria with serious public health consequences. The improper waste disposal, inadequate water supply, and gross inadequacy of sanitary facilities that result in open defecation and urination, as well as overcrowding and exposure of food and meat to flies, rodents and contaminants[8]. The heaps of refuse provide excellent breeding grounds for vectors of communicable diseases including rodents, insects, among others; which increases the potential for the spread of infectious diseases. It is also acknowledged that many of the diseases that affect Nigerians, including malaria, tuberculosis and diarrhea are due to unhealthy environmental conditions[8].

Environmental problems have attracted the attention all over the world. People are becoming increasingly conscious of variety of problems like global warming, air, water and land pollution. Most of the environmental problems could be caused by manmade pollution which not only damage natural resources, but also its effect is also dangerous. Human activities create waste, and it is the way these waste are handled, stored, collected and disposed of which can pose risks to the environment and health[9, 10]. Wastes have adverse effects on the environment thus, necessitating the need to management and control wastes historically.

The leading household wastes sources constitutes product packaging materials such as plastic, paper, metal or glass packaging, which, constitutes over 50% of wastes[11, 12]. The burden of managing wastes is negatively impacted by the high rate of population growth in towns like Oyo Township in Oyo state. The challenges that complicates waste management in urban centers encompasses poor sanitation regulation implementation, limited financial support, lack of appropriate methods to manage wastes.

However, one major solid waste management problem in the urban areas and Oyo town is the lack of refuse collection. Waste management authorities collect refuse from households and public containers on a regular basis only in very few urban communities. As a result, most urban households resort to open dumping of refuse, engage private refuse collectors or burn or bury solid waste. In most cities, the mounds of decomposing rubbish provide breeding grounds for rats, flies, and mosquitoes, contributing to unhealthy environment. Regrettably, the poor environmental knowledge, attitudes and practices associated with solid waste management might predispose the environs to the dangers of air-borne diseases such as whooping cough, asthma, measles, tuberculosis; water borne diseases such as typhoid fever, dysentery, hepatitis and insect/rodent borne diseases such as malaria, plague and Lassa fever[13, 14]. Various researches indicated that there is an association or connection among knowledge, attitude and practices as well as their effect on health, the environments, waste disposal and other issues[13, 15, 16].

Further, there are different techniques of solid waste management but the common techniques are landfill, incineration, composting and anaerobic digestion, and recycling[17, 18]. Although, presently in Nigeria and especially Oyo state is the prominently practiced waste management technique which is open dumping, landfill, followed by open burning; while incineration method is seldom put to practice. Incineration is a cost effective waste management option which is seldom applied in Nigeria[16]. The cheapest and simplest method of waste disposal technique is landfill. The resulting environmental impact of landfills is enormous but could be mitigated provided sanitary precautions are undertaken and waste reduction is advocated[17, 18]. Moreover, recycling which is an environmentally friendly option is not fully adopted. There are no formal recycling sectors in Nigeria[17]. Waste are recycled

informally by scavengers who buy unused valuables from people and also go to legal and illegal dumpsites in search of materials that can be reused and recycled.

Further, solid waste management (SWM) comprises of many drivers that can be used to reduce the volumes of solid waste within the campus, which includes; reusing and recycling materials, composting, and source reduction[19, 20]. Solid Waste within the campus includes used paper, discarded cans and bottles, food scraps, yard trimmings, and other items. It can be said that if solid wastes are not managed properly, many risks and hazards for human welfare can result, although the relative importance of each depends on local conditions[9]. Uncollected wastes block drains, course floods, create insanitary conditions, and are an aesthetic nuisance; discarded cans and other by-products encourage the breeding of flies, mosquitoes and other vectors that spread disease[9].

The waste collection and disposal processes can be overhauled to allow for efficient collection and recycling bins can be put nearly everywhere on campus to ensure a clean environment. Reuse and Recycle containers should be a common thing found in almost all buildings on campus which is to be determined by the demands of the building users, these containers include that of newspaper/Magazines, paperboard/cardboard office papers and discarded book, cans, bottles and plastic containers to mention but a few; but on the contrary it is not so. However, 3R's awareness will be a good incentive to cater for the waste made on campuses. It was highlighted that, a central focus of a waste strategy guided by the need for sustainable development is not just how to dispose of the waste that is produced or even how to recycle it but also how best to reduce the amount that is created in the first place[13]. In a nutshell, 3R's practices comprises different measures and skillful techniques to minimise the volume of discarded waste materials that was generated to dispose out.

In addition, waste management hierarchy is the internationally accepted guidelines for waste management practice, given emphases to reduce waste at source, where waste can be reduced, reuse should be explored, and recycle option should be encouraged if the waste cannot be reused in practice which may yield the positive outcomes to Higher Educational Institutions, especially Colleges of Education in Oyo Township.

Environmental Knowledge is very important on issues of solid waste management and is essential to bridge the gap in knowledge of the solid waste management in developing countries. People's knowledge about the environment develops the specified skills and expertise necessary to deal with the environmental challenges and promote attitudes, motivations, and commitments to form decisions and take responsible actions[8, 13]. Environmental knowledge comprises more than only information about the environment. It rather enhances critical thinking, contributing to solving problems, and allowing effective decision-making skills[13]. Environmental knowledge is a term used to describe concepts and behaviour patterns related to the environment. It is believed that teachers are the primary keys to develop skills of knowledge in students using education to sustain human life, sustainable environmental behaviour, and achieve sustainable development[12]. The upsurge in environmental knowledge raises the awareness of environmental problems, which may likely allow individuals to take action to protect the environment. However, to solve the problem concerning solid waste management, the teacher's SWM knowledge is essential with particular emphasis in developing countries. If Pre-service teachers in developing counties have negative solid waste management practices because they have limited solid waste management knowledge it may affect the environment but if they have positive solid waste management practices because they have adequate solid waste management knowledge it

may help and affect the environmental disposition greatly[12]. This means the pre-service teacher's environmental knowledge is very important on the issue of solid waste management which may ineffectually lead to positive societal effects. Due to the absence of viable environmental knowledge, most of the developing countries have seen their environment destroyed. The inadequate environmental knowledge by most people especially pre-service teachers negatively influences their attitude and practices toward SWM.

Environmental attitudes refer to people's favourable or unfavourable feelings regarding some characteristics of the physical environment[13]. People's attitudes toward the environment and the type of concern they develop toward it are associated with the degree to which they view themselves as being interconnected with nature which may have consequences in the solid waste management practices. Studies have shown that environmental attitudes of children are formed roughly at the age of twelve[12, 13]. That is why children should be taught with a positive attitude toward SWM, through environmental knowledge, which will teach children to respect the environment and its resources. For that matter, the environmental attitudes of pre-service teachers must be critical as they ultimately play a direct role in providing knowledge-based solutions to emerging environmental problems[13]. Meanwhile, if school environmental programmes are directed at students, and they are formulated appropriately, they can impact the environmental knowledge, attitudes, and behaviour on adults, that is, parents, teachers, and local community members, through the process of intergenerational influence[16]. A study conducted on environmental knowledge and attitudes also shows that students can develop high levels of understanding and positive attitudes through the families, teachers, school curriculum, and through reading, studies and information regarding the environment[2]. A positive attitude toward environmental education

can reduce the disparity in solid waste management between the youth and the aged in developing countries. Every school generates waste from routine activities such as classwork, sweeping, serving food, and bush cutting. It is expected that, as part of the learning process, solid waste management activities in schools will involve students by building the right attitudes toward solid waste management.

The poor solid waste management (reduce, reuse, recycle and waste disposal) attitudes and practices may be adduced to poor environmental knowledge of the influence of improper waste management on health. Sufficient environmental knowledge of the impact of waste management on health may help pre-service teachers to protect themselves from diarrhea, typhoid fever, cholera, hepatitis, malaria and other infections. Environmental knowledge, attitude and practice of people on waste management are important for quality living especially the pre-service teachers who will be teachers teaching the younger ones later[13, 14]. Adequate environmental knowledge of the negative influence of poor solid waste management may encourage pre-service teachers to adopt positive solid waste management (reduce, reuse, recycling and waste disposal) practices and positive waste management practices may also promote personal hygiene and the health of the environs[21]. Hence, this study investigated pre-service teachers' environmental knowledge, attitude and practice of solid waste management in Oyo town, Oyo State.

1.2 Statement of the Problem

Anecdotal evidences showed that the major drawbacks concerning solid wastes management, especially in the developing countries are the ineffective waste collection strategies and the lack of disposal sites. It has been suggested, likewise, that practices of basic

solid waste management (SWM) are often neglected at the individual level. While most people are aware of the negative impacts of mismanaged wastes on the environment, their negative attitude coupled with insufficient environmental knowledge among individuals usually corresponds to poor practices towards maintaining good environmental conditions. Despite various programmes by different tiers of government to address the issues of waste management, many still seem to possess low level of environmental knowledge, negative waste management attitudes and practices. Indiscriminate disposal of wastes around undesignated areas which produce offensive odour and de-face the general good aesthetics of the state environment.

In Nigeria and other developing countries, some of the prominent waste management problems witnessed include but not limited to: indiscriminate dumping, poor means of storage, inefficient transportation and insanitary disposal. All these problems are all a function of certain factors which include: population increase, attitude of people towards solid waste management, location of open dump sites without consideration to the surrounding land uses and in most cases these sites are very far from the people. Therefore, this study investigated Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township.

1.3 Aim and Objectives of the Study

This study investigated Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township. The specific objectives were to:

i. ascertain pre-service teachers' types of solid waste produced in Oyo Township;

ii. determine the level of pre-service teachers' environmental knowledge of solid waste management (reduce, reuse, recycle and waste disposal) in Oyo Township;

iii. examine the extent to which pre-service teachers' attitude influences solid waste management (reduce, reuse, recycle and waste disposal) in Oyo Township;

iv. ascertain the pre-service teachers' dominating solid waste disposal practices and solid waste management in Oyo Township;

v. determine the combined influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management (reduce, reuse, recycle and waste disposal) in Oyo Township;

vi. examine the relative influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management (reduce, reuse, recycle and waste disposal) in Oyo Township; and

vii. determine the school type difference in Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township.

1.4 Research Questions

In order to give direction to this study, the following research questions were answered:

1. What is the prevalent type of solid waste produced by pre-service teachers in Oyo Township?
2. What is the level of pre-service teachers' environmental knowledge of solid waste management (reduce, reuse, recycle and waste disposal)?
3. What is the attitude of the pre-service teachers of solid waste management (reduce, reuse, and recycle) in Oyo Township?

4. What is the dominating solid waste disposal practices among pre-service teachers in Oyo Township?
5. What is the dominating solid waste management (waste disposal, reduce, reuse, and recycle) among pre-service teachers in Oyo Township?

1.5 Hypotheses

The following null hypotheses were raised:

$H_0$1: There is no significant combined influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township.

$H_0$2: There is no significant relative influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township.

$H_0$3: There is no significant school type difference in Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township.

1.6 Significance of the Study

The ideas, information and data in this study would be of benefit to the various waste agencies in the state on the need to provide waste bins in strategic locations to reduce indiscriminate dumping of wastes by people. This study would be of benefit to individuals and households in that it would show the right attitude and practices on the issue of solid waste management (reduce, reuse, recycling and waste disposal).

Also, the pre-service teachers would benefit from this study in that it would show their disposition towards solid waste management (reduce, reuse, recycling and waste disposal) in and around the school, and the need to change from negative to positive attitude. This study would show the level of environmental knowledge, attitude and practices of solid waste management (reduce, reuse, recycling and waste disposal).

This study would be of great benefit to the public health professionals to include in their teaching issues having the right attitude and practices of solid waste management (reduce, reuse, recycling and waste disposal) in order to have good health. It would be of great benefit to the policy makers and government in that it would give insight on what need to be done on issues concerning solid waste management and refuse disposal that are being dumped indiscriminately within the state and Nigeria at large. They would also be able to adapt strategies in turning waste to wealth. This study would add to literature on waste management in Social Studies education unit of the Department of Arts and Social Science Education.

1.7 Scope of the Study

This study was delimited to pre-service teachers' environmental knowledge, attitude and practices of solid waste management in Oyo Township. This is due to refuse that are being dumped indiscriminately within classrooms, school compounds and environments. This study was further delimited to pre-service teachers because they were about becoming a full fledge teacher that will be teaching upcoming nursery, primary and secondary school learners within the state. If they have the right environmental knowledge, attitude and practice of solid waste management it will go a long way to affect the young students

positively and the society at large. This study was delimited to Oyo Township due to the fact that Oyo Township is an ancient city within Oyo state and mainly practice traditional method of waste dumping. It was further delimited to the two existing Colleges of Education in Oyo Township namely: Emmanuel Alayande College of Education; and Federal College of Education (Special) Oyo.

Further, this study was delimited to all 200 level students in two selected schools from each of the colleges in Oyo town. The 200 level students were chosen because they were intermediate students. The 100 level students just came into the school system and the 300 level were about leaving the school system. The selected school in the college were School of Secondary Education (Arts and Social Sciences); and School of Secondary Education (Sciences Programmes).

The above schools were selected from each school respectively, based on the fact that the selected schools have high population of students compare to other schools in the colleges; also, Arts and social sciences include Social studies Education as core courses in the school which teaches about the environment; and sciences has subject areas that teaches about environment and management of solid waste.

1.8 Limitation to the Study

In the course of this research, certain constraints were encountered. The respondent sampled were drawn from only the students of the colleges of Education in Oyo Township. Also, Emmanuel Alayande College of Education was on strike for few months at the start of the field work, which made the researcher to start the gathering of data with Federal College of Education Oyo (special) only. Then, when the strike was called-off data was also gathered

from them. These caused a little delay in the time frame. Regardless of all these constraints these findings can still be generalised, that is, the ideas, information and knowledge from this study can be used among other colleges and schools; the results of the finding can be used in Oyo State and all other states of the federation and the world at large.

1.9 Operational Definition of Terms

The following terms were defined the way they were used in this study to remove ambiguity and vague meaning:

Waste: This refers to unwanted or unusable materials which is any substance discarded after primary use, or is worthless, defective and of no use.

Management: This is the process of dealing with or controlling solid waste made within the classroom/school.

Waste Management: This refers to the care in manipulation, treatment, use or control of solid waste made within the classroom/school in an acceptable, aesthetically and economic manner.

Solid Waste Management: This is the process of reusing, reducing, recycling, and disposal of solid wastes made within the classroom/school in such a way that they are harmless to humans, plants, animals, the ecology and the environment generally.

Reuse: This refers to the pre-service teachers using a waste product again from the original use without further transformation and without changing its shape or original nature. For example, bottles, old clothes, books among others to ensure that less solid waste is produced.

Recycling: This is the process of collecting and processing materials used by the pre-service teachers that would otherwise be thrown away as trash and turning them into new products.

Reduce: This refers to anything that reduces waste used by the pre-service teachers through using less materials in the first place. For example, using both sides of a sheet of paper, skip plastic straw, reuse water bottles, composting and not the one that ends in landfill.

Waste Disposal: This refers to the activities and actions required to manage waste from its inception to its final disposal, it is the collection and dumping or destruction of food waste and other discarded material by the pre-service teachers.

Solid Waste: These are any garbage, refuse and other discarded materials including papers, bottle, can, nylon bags, files, foods, among others and from pre-service teachers' domestic activities.

Environment: This is the surroundings or conditions in which pre-service teachers live or operate (geographical area).

Environmental: This is relating to or arising from pre-service teachers' surroundings.

Pre-service Teachers' Environmental Knowledge: This refers to facts, information, and skills on the surrounding (environment) acquired by pre-service teachers through experience or education, the theoretical or practical understanding of the solid waste.

Pre-service Teachers' Attitudes: This refers to how pre-service teachers think and feel about their environment in order to prevent problems/issues of solid waste management (reduce, reuse, recycling and waste disposal), this attitude could be cognitive, affective among others.

Pre-service Teachers' Environmental Practices: This refers to overall behavioural habits to repetitive act of the pre-service teachers within their environment that will ensure good or bad solid waste management that encompasses reuse, reduce, recycling and disposal.

Pre-service Teachers: These are students enrolled in a teacher preparation programme who must successfully complete degree requirements including course work and field experience before being awarded a teaching certificate.

Endnotes

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Chapter Two

Literature Review

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2.1.2 Types of Waste

2.1.3 Concept of Waste Management

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2.1 Conceptual Review

2.1.1 Waste

Waste are unwanted materials, substances or objects which are disposed or intended to be disposed-off by the provision of the law at state or national levels. It can further be seen as substances or objects discarded as useless or unwanted from human and animal activities. Waste can be generated during the extraction of raw materials, processing of raw materials into intermediate and final products, consumption of final product and other human activities[1]. In real sense, wastes include all items that people no longer have any use of, which they either intend to get rid of or discard due to their hazardous nature.

2.1.2 Types of Waste

Some types of household wastes consist of a variety of materials. The best overall household waste composition estimated currently showed a (20%) of garden waste, 5% wooden wastes, 18% paper dirty, 9% sweeping wastes, 17% kitchen wastes, 3% of metallic material waste, 3% of both textile and soil wastes as the components of household wastes when they were broken down[1]. In the Organisation for Economic Cooperation and Development, wastes can be classified into three major areas in line with how they are generated[2]. The three classes are as follows:

i. Community: This consists of household waste, commercial and trade waste, waste from office building, institution and small scale businesses, yard and garden, street sweeping, contents of litter containers, school cleaning and so on.

ii. Hazardous waste: This is mostly generated by industrial activities which relates mainly to toxic contamination of soil, water and air. This type of waste creates serious environmental risks if not properly managed.

iii. Nuclear (radioactive) waste: This is generated at various stages of nuclear fuel cycle such as uranium, mining and milling, fuel enrichment, reactor operation and fuel reprocessing. It also arises from decontamination and decommissioning of nuclear facilities and from other activities using isotope such as scientific research and medical activities.

Considering the three classes of waste above, the Federal Government of Nigeria at the 2005 Environmental statistics workshop in Dakar, Senegal presented some critical problems generated from waste and which serve as major concern in relation to the health of the populace. In relation to this, it was identified that high rate of urbanisation, rising standard of living results in increased generation from waste[2]. Also, looking at the developing countries,

it was identified that rapid social development, population growth, resource exploitation and unchecked technological advancement create the main problems of waste[3]. Also, developing countries are busy improving access to clean drinking water, they are falling behind on sanitation goal especially on the disposal of wastes when compared to developed countries of the world[4].

Community waste [Management of Solid Waste (MSW)] sources encompasses business activities, institutions, households, and organisations, with the major elements of MSW comprising of plastics, wood, rags, metal, food among other wastes[5, 6]. Building demolitions and construction wreckages contribute hazardous wastes like batteries bulbs among others in the debris are a health hazard to human and environmental health[6].

Industrial waste incorporated are bundling materials, waste from food manufacturing and processing, oils, solvents, resins, paints and sludge's, glass, pottery, stones, metals, plastics, rubber, cowhide, wood, fabric, straw, abrasives, and so forth[6]. Similarly, the community waste, the absence of a consistently up-dated and methodical database on industrial waste guarantees that the correct rates of age are to a great extent obscure. Farming waste and buildups have likewise been acquired through growing rural creation bringing about expanded amounts of livestock waste, agrarian harvest deposits and agro-industrial results[7].

A study conducted on the impact and influence of waste on environmental and human health highlighted the sources of types, amount, disposal methods, and adverse effects of poor waste management on health[8]. The liquid, excreta from community and households forms the dangerous health threats from wastes that contribute to causes and spread of infectious infections in the society as the findings illustrates.

A study on industrial wastes include the wastes generated during the production process like traffic, resource development[9]. The study dealt with the various economic industries and their associated wastes like mining, power, chemical, oil, light, and metallurgical industries and the coefficient of waste generation.

2.1.3 Concept of Waste Management

The business of keeping our environment free from the contaminating effects of waste materials is generally termed waste management. There were number of concepts about waste management which vary in their usage between countries or regions. Some of the most, general, widely used concepts referred to the '3 Rs ', Reduce Reuse and Recycled which classified waste management strategies. Waste management involved the collection, transport, treatment and disposal of waste including after care of disposal sites. Similarly, waste management can be seen as "purposeful, systematic control of the generation, storage, collection, transportation, separation, processing, recycling, recovery and disposal of waste in a sanitary, aesthetically acceptable and economical manner"[9]. While community waste management can be defined as the collection, transfer, treatment, recycling, resource recovery and disposal of waste in urban areas[8]. It can be deduced from these definitions that waste management is the practice of protecting the environment from the polluting effects of waste materials in order to protect public health and the natural environment. Thus, the priority of a waste management system must always be the provision of a cleansing service which helps to maintain the health and safety of citizens and their environment[10].

Further, the business of waste management as a professional practice which goes beyond the physical aspects of handling waste. It also involves preparing policies,

determining the environmental standards, fixing emission rates, enforcing regulations, monitoring air, water and soil quality and offering advice to government, industry and land developers, planners and the public[7]. Waste management, therefore, involves a wide range of stakeholders who perform various functions to help maintain a clean, safe and pleasant physical environment in human settlements in order to protect the health and well-being of the population and the environment. Effective waste management is, however, a growing challenge to all community governments, especially in developing countries. There are many factors that have been thought to be associated with this phenomenon in developing countries.

In addition, waste management is the generation, prevention, characterisation, monitoring, treatment, handling, reuse and residual disposition of materials produced by human activities in order to reduce their effect on health and the environment[8]. Of all the community waste generated, waste from trade in the markets and marketing sweeping need to be looked into[2]. This is due to the fact that the product from these markets are either consumed raw or processed before consumption and can be hazardous to human health if not properly taken care of. Globally and considering the above assertions and notion the disposal of waste which has created numerous challenges may not be seen as the real problem, but its management by different nations of the world. The management in the real sense refers to people's habit and behaviour towards the said waste.

2.1.3.1 Solid Waste Management

Solid waste management is understood as supervised handling of waste materials from source through recovery processes to disposal; and, it involves control of generation, storage, collection, transportation, processing and disposal of solid waste with the aim of protecting environmental quality, human health and preservation of natural resources[11]. In

addition, solid waste refers to non-liquid material that is no longer valuable to the owner as including rubbish, garbage, trash, or refuse; examples include kitchen waste, paper products, rags, plastics, rubber, leather, bone, glass, crockery, pots, sweepings, metal and old furniture as generated by households, offices, hotels, shopping complexes/shops, markets, yards, schools, institutions and street cleaning; categorized as household/domestic, commercial, institutional, industrial and agricultural waste; and, excluding semisolid waste such as sludge and night-soil (liquid waste) and clinical waste produced by hospitals[11, 12].

Further, solid waste management which is done along the lines of a systematic utilisation of reducing, reusing and recycling depends on managerial procedures, practical choices and state-of-the-art strategies. A study found that effective reduction, reusing and recycling of waste are achieved with the support of relevant equipment and use of experienced personnel; the reverse is true, lack of equipment for waste crushing or refining processes derails the process; while, inexperience personnel decreases the success rate[12].

As an elaboration, the '3Rs' model is considered as state-of-the-art philosophy of waste management. The 3-tier-R has been expanded into six hierarchical steps: prevention, reduction, reuse, recycle, energy recovery and disposal[9, 10]. For the municipal waste managers, a comprehensive understanding of the '3Rs' model is critical. Used as conservation approach, the emphasis is laid on reduction, reusing and recycling of bio-degradable and non-biodegradable waste; and, providing an environmentally friendly option to manage waste[9]. Upon completion of the '3Rs' processes, the maximum benefit is minimization of waste volume, decline in the reliance on landfills, decrease in the environmental costs associated with management, and improvement in serious public health concerns.

2.1.4 Strategies for Waste Management

The continuously increasing waste generation worldwide calls for innovative strategies that integrate concerns for Sustainable Development in waste management. It was indicated that every nation needs to develop a strategy for waste management and that the objective of any strategy for waste management should be to improve upon the approach to waste management, which in most developing countries is disorganised, haphazard and under-resourced[11].

Waste management is a complex sector with varied interest groups[12], who are expressing increasing concerns about the appropriateness of various strategies and technologies in managing solid waste globally. With high public awareness about the problems posed by inadequate waste management and the negative effects of some waste management technologies, broad consultation and involvement of all stakeholders are needed in the development of a workable waste management strategy.

Therefore, any strategy should compose of a systematic assembly of policy choices made at a given point in time, within the national context, that builds upon and addresses the fundamental elements and situation and gap analysis while giving particular emphasis to priority issues[13]. Hence, to develop effective waste management strategies, developing countries which are engulfed with waste management challenges need to consider their present waste situation and embed their strategies in their national development plans.

Presently, raw materials are becoming scarce and energy more expensive, and all around the world, soil, air and water pollution pose a risk to sustainable development[12]. Waste management is closely associated with these problems, as waste disposal issues are exacerbated by changing patterns of consumption, industrial development and urbanisation.

This means that the traditional systems for solid waste disposal and recycling are no longer appropriate[13].

Consequently, in Europe and other parts of the globe, waste is increasingly being used to produce both materials and energy, and recycling now saves more greenhouses gases than it generates[14]. For instance, the focus of the European policy on environmental protection has shifted to a more encompassing aim of protection and mitigation, with subsequent policy and legislation setting out a more general framework for the handling, storage, treatment and disposal of all waste streams.

The European policy on environmental protection is reflected by the principles that are included in the Fifth European Commission (EC) Environmental Action Programme - '*Towards Sustainability*', which is the foundation of waste management legislation in Europe[9] (Table 2.1 indicates the principles of EU Waste Management Policy).

However, many developing countries, especially sub-Saharan African countries, are still faced with the major challenge of improving their inadequate and unsustainable waste management systems to cope with the rising population, urbanisation and economic growth, which are leading to increasing MSW generation rates[15, 16].

Table 2.1: The principles of European Union Waste Management Policy[9]

Principle	Description
Waste Management Hierarchy	A ranking of waste management options, from the most to the least desirable: reduction, reuse, recycling, recovery and optimum final disposal as well as improved monitoring.
Proximity	Waste should be disposed of as close as possible to its point of origin, to reduce waste movements
Self-Sufficiency	A network of integrated waste disposal facilities should exist throughout the Member States in the Community, with co-operation between countries ensuring that waste generated within the Community is only disposed of within the Community.
Best Available Techniques Not Entailing Excessive Cost (BATNEEC)	Processes should be optimised and associated emissions from installations should be minimised, while still being economically efficient.

Source: [9]

1. The Waste Management Hierarchy

The waste management hierarchy is the most popular concept globally. It was first adopted in the 1970s when disposal-based waste management was criticised by the environmental movement and environmental advocacy groups that arose out of the movement because the method appeared to be unsustainable[16]. Members of the movement

argue that instead of considering SW as a consistent mess, it must be seen as being composed of a variety of constituents that need to be treated using different and appropriate methods.

Hence, the waste hierarchy comprises a set of options for attending to waste, preferentially ranked in terms of their perceived environmental benefits[17]. The proponents of the waste hierarchy contend that when waste is created the priority is how it can be reduced, reused, recycled, and recovered before final disposal.

Thus, disposal (effectively landfill) and recovery (as energy) are at the bottom of the hierarchy, recycling or materials recovery is in the middle, and (preparation for) reuse or reduction and prevention at the apex[17], as shown in Figure 2.1. The overarching aim of the waste hierarchy is to extract the maximum practical benefits from products while generating the minimum amount of waste.

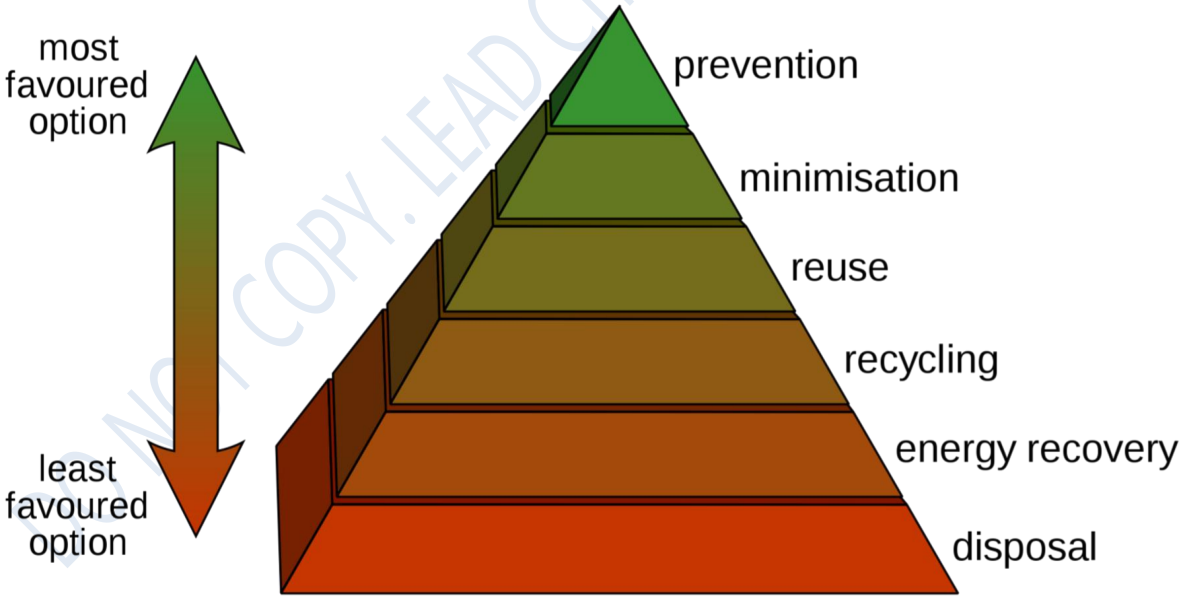

Figure 2.1: Waste management hierarchy[18]

Therefore, the waste management hierarchy classifies waste management strategies according to their order of importance and is the cornerstone of most waste minimisation strategies[19]. The waste hierarchy approach is a strategy finalised to avoid, eliminate and prevent the causes of waste environmental problems and hence is comparable to the popular saying in human health and medicine that: '*prevention is better than cure'*.

Consequently, many modern environmental legislations include principles of minimising impacts on the environment and conserving natural resources[19]. These legislations follow the waste hierarchy concept, which among other things, gives preference to recycling or reuse of material over waste disposal[9].

However, the waste hierarchy seems to be more prominent in Europe than elsewhere. Accordingly, some researchers observe that the waste hierarchy has become more entrenched in EU legislation than the US legislation, though the idea of the waste hierarchy was formulated in the US[9]. This is probably because many critics of the waste hierarchy are of the view that it is inflexible and suggest that where clearly a better environmental outcome can be shown, the hierarchy strategy should be avoided[20].

Also, the implementation of the waste hierarchy has emphasised the less desirable alternatives to landfill[20] nonetheless, due to high changing patterns in consumption, landfilling will always be necessary for the disposal of residue from other waste processing/treatment methods. Moreover, waste that is technically suitable for recovery does not automatically become a raw material if there is no school for it, or its use is not commercially effective and, hence, should be disposed of.

Again, the waste hierarchy requires adequate legislation for its implementation and may not be applicable in all locations, especially in some developing countries, where there

are inadequate legislation and poor institutional framework for waste management. Therefore, many researchers are of the opinion that, treatment and processing of SW should target minimising the volume of landfilled waste, whilst recovering as many resources out of it as possible[10].

2. Material Recovery and Recycling

Originally, managing waste was about protecting human health and maintaining environmental amenity, however, since the 1990s, SD came to prominence and waste recycling has become a priority[16].

Resource recovery has been a major element in WM, especially in developing nations, through the informal sector, where scavenging for recoverable materials is a source of livelihood for many people. Thus, in most developing countries, a lot of recovery and recycling takes place informally in such a way that some materials do not enter the community waste stream[20].

Recycling or materials recovery is in the middle of the waste management hierarchy and is an applicable waste reduction method in both developed and developing countries. In the past, reclaimable inorganic components were recovered mostly by way of unregulated manual scavenging by private individuals, however, in recent years, the trend has been formalised and mechanised scavenging is practiced through the establishment of material recovery facilities in some developing countries[20].

Moreover, attention is now given to the recovery of organic waste in most developing countries since organic waste constitutes at least 50% of the waste stream[21]. The resource recovery aspect regarding the organic component is threefold: the component can be used in agriculture as a soil amendment through composting, its energy content can be recovered

either biologically or thermally, and the organic content can be hydrolysed either chemically or enzymatically to produce sugar[6].

For example, Accra Compost and Recycling Plant (ACARP), an integrated waste processing and recycling company established in Accra, Ghana in July 2012, is helping to solve the plastic waste menace in Accra and other parts of Ghana, through the recycling of plastic waste into high quality pelletized plastics as raw materials for other local industries for further production into various plastic items[1]. ACARP also recovers materials such as textiles, packaging materials and other highly combustible materials which are also used for the manufacture of high calorific burning materials for specific industries[1]. In Nigeria, precisely in Ibadan an integrated solid waste recycling facility was built in 2005 by the Oyo state government at Orita Aperin without prior information generated in the area and many follows in other areas in Oyo state[22].

Nevertheless, recycling process itself can lead to the introduction of pollutants in goods and reservoirs. For example, the recycling process can increase heavy metal contents in recycled plastics, or it can lead to accumulation of metals in the soil when sewage sludge is applied to agricultural fields[9]. Also, the challenge with material recovery and recycling in most developing countries is the processing of mixed waste to recover materials. The success of these will depend upon the degree of source separation of the waste, as well as the types of materials to be recovered.

Presently in most developing countries including Nigeria, there is no separation of waste at the generation point. This hinders material recovery and recycling. Conversely, the initial cost of waste processing facilities for recycling is a deterrent to most developing

countries which are still struggling to provide basic amenities such as potable water to their citizenry[23].

Reduce

This involves the reduction of wastes at the point of generation or before final disposal. It also involves the consideration and incorporation of necessary SW management principles starting from the material design through all the processes to the eventual material consumption[22]. It significantly reduces the quantity as well as the harmful effects of SW generated. This can also be achieved by the use of less but quality material resources in product manufacturing incorporating the principle of reusability of the products through the production and design stages. This will contribute immensely in actualizing solid waste reduction strategy. Industries have major roles to play in the reduction of solid wastes[9]. They can adopt more efficient manufacturing processes by making larger quantities of products without increasing the use of raw materials. In other words, incorporating lesser materials in making products[9]. Another important strategy of achieving waste reduction is the separation at source. This is achieved by providing separate bins/containers, which are clearly labeled, at designated places of collection or generation points like households, industries, workplaces, commercial areas, offices, among others[23].

Some of the possible ways of reducing the quantity of solid waste generated include buying products that involve less packaging or buying products in bulk so as to reduce the quantity of materials used for the packaging; making use of reusable items rather than the disposable ones, for instance, the use of handkerchiefs rather than tissue papers, rechargeable batteries, refillable ink pens, among others; making use of cotton/textile bags for shopping

rather than plastic bags; maintaining/repairing of damaged products like clothes, leathers, furniture, among others.

To reduce waste means to minimize amount of waste generated. Waste reduction could be achieved through legislation, product design, local programmes to keep recyclables and compostable from the waste[9]. Waste reduction stresses upon judicious use of resources in manufacturing. Legislation compels a manufacturer to maintain particular standards in designing products or limit production activity as happens in Europe and USA[9]. Also, separation of waste at source achieves the same goal of waste reduction; intensified by public awareness and education.

Reuse

This involves the use of discarded or disposed-off materials in their original form without transforming them. It also involves the collection of discarded useful products from sources that no longer make use of them and passing the supposed wastes to the ones that can still make good use of the materials. Solid wastes that can be reused include glass bottles, PET bottles clothing, papers/cardboards, leathers, food leftovers, metals, and anything that can be used for a similar purpose to the first intended[18]. These instances clearly indicate that reuse is a very important aspect of solid waste management that can foster sustainability. Reuse involves secondary and subsequent uses of waste materials either in part or whole. Reuse of waste is exemplified by trade in second-hand goods: cloths, electronics, automobiles, furniture and other merchandise[19]. 'Reuse' is achieved through sorting done at source rather than disposal site; and, through detailed processes of checking, cleaning, refurbishing, repairing whole items or spare parts[9].

Recycling

This involves the reprocessing or transformation of waste materials into other forms before use. When wastes are recycled or treated, they become valuable resources rather than wastes. For instance, paper wastes can be transformed into new paper products that can be used for different purposes like printing, tissue papers, cardboards, among others; metal wastes and glasses can be melted and transformed into other useful metal and glass products; plastic bottles can be transformed into plastic ropes or coating rubbers for electric wires. Recycling processes majorly include composting and all waste-to-energy processes[9]. Recycle depends on waste materials which cannot be reused directly but can be converted to new product or raw material through the processes of transformation. For instance, used paper is recycled into files, envelops and cards[10]. Energy is recovered through recycling through: pyrolysis (combustion of waste in the absence of oxygen to create gases, liquids and solid compounds), incineration (combustion in the presence of oxygen to produce oxidized compounds), anaerobic digestion, gasification and pelletization; as well as composting (biological and chemical degradation of organic waste in either large centralized, small enterprise, backyard or household basis) [9].

However, access to possible recyclable material possesses great difficulty due to poorly limited recycling programs. The informal recycling programmes involve scavengers' effort search of recyclable items. Presently, the informal sector renders the service of retrieving and recycling of materials in Nigeria. The introduction of an advance formal recycling programme presents positive and accelerating outcomes for municipal waste management sector.

3. Zero Waste Approach

Zero waste (ZW) is one of the most visionary concepts for solving waste problems[7] in a whole-system approach that aims to eliminate rather than manage waste. It encourages waste diversion from landfill and incineration because ZW has the philosophy of eliminating waste at source and at all points down the supply chain[24].

Thus, the Planning Group of Zero Waste International Alliance (ZWIA) adopted the definition of Zero Waste as a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use. ZW means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. Implementing ZW will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health[26].

Subsequently, other organisations that wish to achieve holistic ZW goals have adapted and utilised this working definition. For instance, ZW in England is defined as: a simple way of encapsulating the aim to go as far as possible in reducing the environmental impact of waste; it is a visionary goal which seeks to prevent waste occurring, conserves resources and recovers all value from materials[24].

The pioneers of the ZW were very clear that ZW to landfill was not the same as ZW[26]. Further, it was argued that ZW is about making the best choice with natural resources – from extraction to production to consumption to disposal. The emphasis of ZW approach is on avoiding waste created by the constant evaluation of materials choices and a strong

commitment to eliminating waste, not just treating waste. Therefore, ZW is completely opposed to waste disposal in landfill and Waste technologies.

Consequently, in a review of the development of ZW management between 1997 and 2014 it was observed that the concept has been embraced by policymakers because it stimulates sustainable production and consumption, optimum recycling and resource recovery[24]. Thus, ZW's implementation is not limited to only waste management but is equally applicable to mining, manufacturing, and urban development.

ZW is seen as the best practice in Integrated Waste Management (IWM) because it is comprehensive, thorough, emphasises prevention first in the strategies employed, and fosters local value-added manufacturing opportunities for the collected materials[24]. Nevertheless, ZW is not a feasible concept of waste management presently in anywhere in the world due to its major economic and financial implications. It is inevitable to avoid waste generation in this era that more resources are needed to meet the developing needs of nations.

Also, ZW implementation requires adequate legislation, good institutional framework and efficient waste governance. These are lacking in most developing countries and as such, its application is not practicable in these countries. Waste reductions are the focus of most present waste management concepts and not outright avoidance of waste generation. The idea of completely eliminating waste is highly unrealistic currently, rather, the approach should be espoused for waste to be handled in such a manner that does not harm the environment while optimising the resource potentials of waste for SD.

4. Cradle-to-Cradle / Cradle-to-Grave

The cradle-to-cradle framework seeks to create production techniques that are not only efficient but are really waste free[24]. It was underscored that the cradle-to-cradle concept

focuses, first and foremost, on defining the intention behind the design of a product in terms of its positive impact with the objective of avoiding waste completely[13].

The cradle-to-cradle concept and the ZW approach have a similar objective of avoiding waste, however, the cradle-to-cradle concept is not opposed to material recovery from waste because all materials are inputs and outputs during production. Thus, for the cradle-to-cradle concept, rather than ultimately ending up as waste, the materials in a product at the end of its useful period begin a new life in a new cycle, at the same level of quality, time and again[13]. Thus, waste is always a resource and its generation is avoided completely.

In contrast, cradle-to-grave refers to a company taking responsibility for the disposal of goods it has produced, but not necessarily putting products' constituent components back into service[7]. The meaning of the cradle-to-grave concept can be simplified that cradle is where life starts and the grave is where life ends.

No matter how a particular waste is reused, there comes a point that it must be disposed of. Therefore, cradle-to-grave is used in reference to a company's perspective on the environmental impact created by their products or activities from the beginning of its life cycle to its end or disposal[7]. This concept focuses on ameliorating the negative impacts of waste emanating from a product throughout its lifecycle.

In order to apply both cradle-to-cradle and cradle-to-grave concepts in WM, materials must have a known, well-defined chemical composition; materials must be either biological nutrients (that is, safe to return into a natural biological cycle) or technological nutrients; and the products must be designed for easy disassembly[13]. These call for forms of interaction along the supply chain of products between producers and consumers which is unlikely because there is usually no direct link between producers and customers.

5. Integrated Waste Management (IWM)

Integrated waste management (IWM) is an evolving concept, which is the interlinked stages of a system to collect, process, treat, and dispose of waste. Initially, IWM was developed to increase the efficiency of WM chain, through source separation, collection and transportation, transfer stations, treatment and final disposal but later became an umbrella management system to coordinate all waste types from all the waste sources (residential, commercial, industrial, healthcare, construction and demolition and agriculture) within a geographic or administrative boundary such as a city[24].

IWM refers to the strategic approach to sustainable management of SW covering all sources and all aspects, covering generation, segregation, transfer, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency[11, 12], as shown in Figure 2.2. Waste management operations and strategies are incorporated in an integrated approach that includes a hierarchy of waste management alternatives, including waste avoidance, resource recovery, and environmentally sound treatment and disposal[6] in the IWM concept. Therefore, this concept can be described as the agglomeration of all WM concepts/strategies.

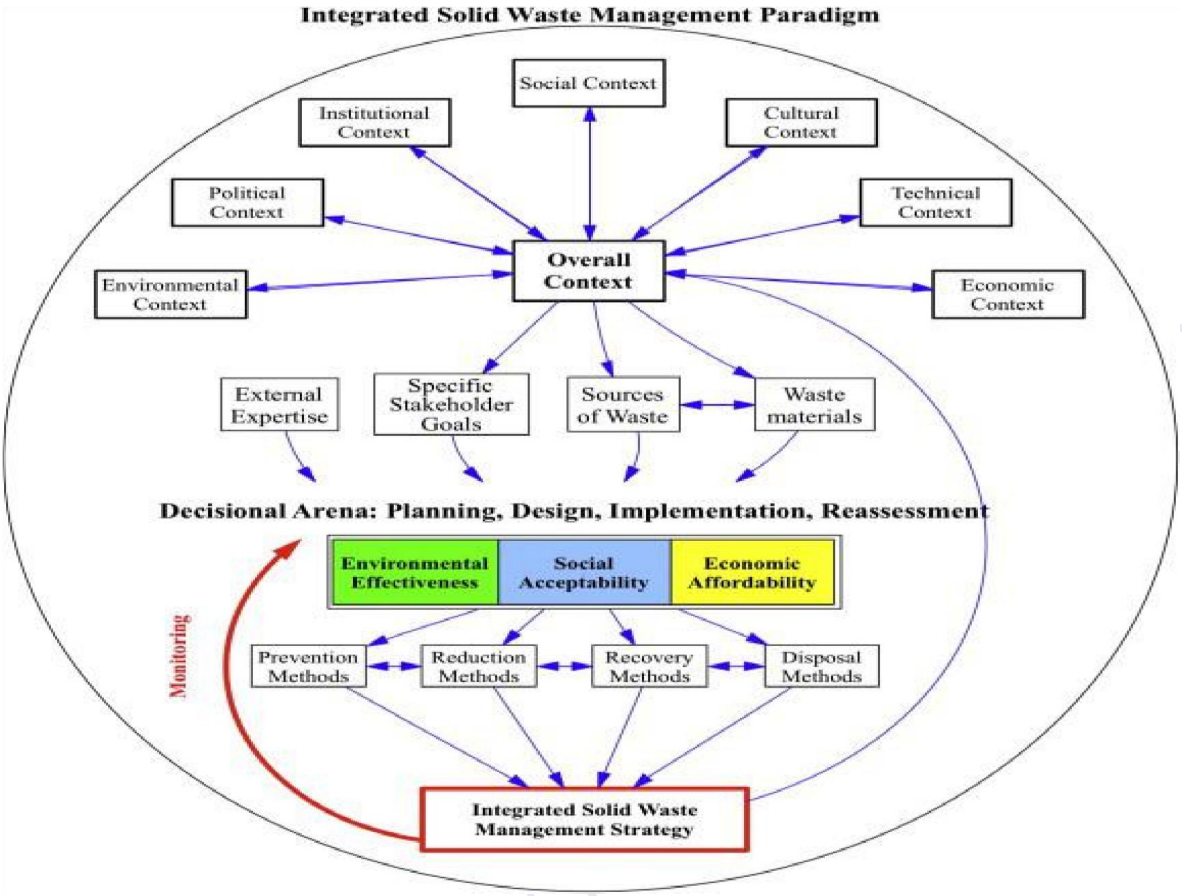

Figure 2.2: Integrated waste management Framework[12]

The initial point of an IWM system is the possibility of waste reduction, choosing the optimal ways of its treatment starting from its creation to its final handling and its transformation into something safe for the environment and the well-being of people[11]. This concept thrives on adequate data and information on waste characterisation and quantification (including future trends), and assessment of the current management system (the baseline scenario)[11]. Accordingly, the waste management systems that operate successfully in various parts of the world indicate that a single option is not suitable to handle efficiently the full array of solid waste management[13].

There are many alternatives for the management of SW including recycling, biological treatment, thermal treatment, and landfill disposal, however, the selection and mix of these alternatives must be technically and economically sustainable based on local considerations. This is because integrated waste management requires making informed decisions to optimise waste management by minimising environmental releases, energy and resource use, and costs while maximising useful outputs. Therefore, good judgment is required to balance these factors for a given region[24]. As such, all realistic methods of waste management must be considered, including recycling, combustion, composting, and landfilling.

However, the use of several of these processes in a waste management system may be too expensive for most developing countries. Currently, waste management systems in most developing countries are contending with the barriers of socio-political, technological, regulatory, financial, and human resources constraints[13]. Nevertheless, combining several waste treatment options in an integrated manner is the way to solving WM problems as various streams of waste require different processing or treatment technologies.

6. Management of Solid Waste Processing and Treatment Technologies

Waste processing and treatment is the core means to reach the WM objectives in terms of protection of human health and environment, economic development, and fulfilment of social and regulatory requisites[5]. Waste processing issues are addressed in diverse ways in different countries, regions, cities and towns because much depends on the local conditions, financial possibilities and other factors[14].

The technology options available for processing and treatment of SW are based on either bioconversion or thermal-conversion processes[14], as outlined in Table 2.2. The

bioconversion process is applicable largely to the organic waste, to form compost or to generate biogas such as methane[14], whereas the thermal conversion technologies are incineration with or without heat recovery, pyrolysis and gasification, plasma pyrolysis and palletisation or production of refuse-derived fuels (RDF)[16]. The thermal conversion technologies are generally not suitable for SW of high organic content, because the calorific value of waste is influenced by its moisture content.

Table 2.2: Technology Options Available for Processing and Treatment of MSW[14]

Bioconversion Technologies	Thermal Conversion Technologies
Composting	Incineration
Anaerobic digestion	Pyrolysis
Fermentation	Gasification

Source: [14]

Opinions differ on the effectiveness of these technologies for the processing and treatment of SW[14]. This is because waste infrastructure has a long lifetime and care needs to be taken at the start to ensure systems can adapt to potential long-term changes[15]. Thus, the flexibility of a technology to future change is usually the key consideration in the choice of a technology. Nonetheless, the appropriate selection of a technology is equally dependent on many factors such as technological efficiency, economic benefit, and social and environmental acceptability[23].

i. Bioconversion of SW

Biochemical conversion of SW uses biological agents (enzymes and microorganisms) to break down organics for biogas production and collection of value added products[16]. These processes are able to convert not only medical solid waste but other biomass waste such as sewage sludge, plastic, tires, agricultural residues and the like, as well as coal, to useful

products such as hydrogen, ethanol and acetic acid[16]. The end product of any bioconversion technology is either the production of clean energy in the form of biogas which can be converted to power and heat using a gas engine or compost which can be used as a soil conditioner[27].

a. Composting

Composting is the aerobic decomposition of biodegradable organic matter in a warm, moist environment by the action of bacteria, yeasts, fungi and other organisms[27]. Factors affecting the rate and completeness of decomposition are manipulated according to local needs and constraints to produce the desired decomposition[23]. These factors include waste selection or exclusion, particle size reduction, mixing, seeding, moisture addition, and aeration.

Composting produces a product that is biologically stable and free of viable pathogens and plant seeds and can be applied to agricultural lands to improve the soil nutrients. It conserves nutrients in waste (N, P, K) and increases soil carbon content and moisture holding capacity[15, 24]. Thus, composting is the most widely used process for treatment of organic SW, especially in developing countries where organic waste is the dominant component of the SW stream[15].

More costly facilities (usually in developed countries) use mechanical methods to prepare the waste and to promote decomposition, whilst less costly facilities (in developing countries) emphasise natural processes, reducing mechanical needs[15]. In general, composting involves three basic steps: pre-processing which involves size reduction and nutrient addition; decomposition and stabilisation of organic material; and post-processing which involve

grinding and screening[24]. These processes reduce the volume and weight of waste by approximately 50% and result in a stable product that can be applied in agriculture[15].

There are various technologies available for composting but the most common technologies are aerobic, anaerobic and vermicomposting[24]. Vermicomposting is a recent technology for MSW and sludge management[24]. It is basically the breakdown of organic matter by some species of earthworms[16]. The dropping of the worms together with the broken organic matter makes vermicomposting to be nutrient-rich than other compost and thus, can be used as a natural fertilizer and soil conditioner.

Many researchers observe that composting is the cornerstone of sustainable development in the waste sector, and therefore, suggest that composting should be a more widespread practice in developing countries, because it can be implemented at small and large scales[14, 16]. However, large and centralised composting plants are often not economical, due to high operational, maintenance and transportation cost in developing countries[24].

The viability of commercial composting is usually dependent on the availability of a ready school for the final compost product. Subsistence farming is still widely practiced in most developing countries, with farmers depending on their own animals' droppings for manure. The demand for compost may not be able to meet the production cost in most developing countries. For instance, it was indicated that in Nigeria, composting of MSW has failed in various regions of the country due to lack of funds for maintenance because there were no ready markets for the compost produced[5].

On the other hand, Nigeria in the same West African sub-region with Ghana is reducing fertilizers import due to composting. Ghana used to spend over US$ 63 million annually on fertilizer subsidy to farmers, however, ACARP's compost fertilizer which is now

utilised across the country has helped to reduce Ghana's over-dependence on imported fertilizers[7, 28]. Nonetheless, composting cannot be regarded as a panacea to today's waste management problems but should be an important component within an IWM system in developing countries[28].

On the environmental burdens of composting, in a report to the US EPA observe that although composting has a long history and has been the subject of much research and development, little is known about the extent of decomposition; because of this, there is no information on the amount of gases produced during decomposition and only general information and theoretical projections of the gas composition are usually made[28].

Carbon dioxide (CO_2) and ammonia (NH_3) gases are the primary metabolic byproducts of the composting process[28]. CO_2 is a well-known greenhouse gas; however, little is known about the actual yields and production rates of CO_2 and NH_3 in composting[28]. Also, no significant amounts of leachate are produced in composting facilities, if the compost is covered and the moisture content is kept near optimal values. For this reason, leachate production within the composting facility is often assumed to be negligible.

Composting of SW in developing countries has the potential of reducing GHG and leachate emissions from open dump sites, the quantity of waste that is landfilled, and the high import bill on fertilizers. Also, the resource potential of SW through composting presents business and job opportunities that can assist in the fight against poverty and underdevelopment and ensure food security in many developing countries.

b. Anaerobic Digestion

Anaerobic digestion (AD) is the natural biological process which stabilises organic waste in the absence of air and transforms it into bio-fertilizer and biogas[28]. AD is either a

wet process used for materials with moisture contents more than 85% or a dry process used for materials with moisture contents less than 80%[27]. AD is rapidly developing as the main technology for wet household organics, manures and slurries, and is particularly suitable for food waste which is usually high in moisture content[27]. Through the AD process, it is possible for organic waste from various sources to be biochemically degraded in highly controlled, oxygen-free conditions to result in the production of biogas which can be used to produce both electricity and heat[27].

In comparison with composting, AD processes require less energy input than aerobic composting and also creates much lower amounts of biologically produced heat, although additional heat may be required to maintain optimal temperatures in an AD process[13]. AD technology has been implemented widely across the globe for many years. While some AD implementations have been successful, others have failed woefully, particularly in some developing countries. An AD project named '*TAKA'* (waste) was successfully implemented in Tanzania which indicated that the project is dealing with the growing problem of MSW and produces biogas for electricity production[24]. On the other hand, biogas plants that were installed in Ghana in the early 2000s all failed due to inadequate waste supply to the plants and lack of technical expertise in managing the plants, however, new biogas plants are currently under construction across the country, especially in senior high schools for faeces sludge management[24].

c. Fermentation

The fermentation process is used to manage waste and produce fuel[13]. It is mostly used in industries that produce food and drink products in many countries. It is a metabolic process that converts sugar into acids, gases, and alcohol in the presence of yeast and

bacteria[9, 13]. Like in the AD, in the SW fermentation process, the waste is acted upon by yeast and bacteria in the absence of oxygen to produce ethanol, acids, and trace of gases which are eco-friendly fuels[27].

Despite these, the use of fermentation as a waste treatment technology is limited to only breweries in most developing countries. Even in industrialised countries, there is no evidence of its application for general WM. Nonetheless, fermentation is an emerging technology worth considering for WM in developing countries.

ii. Thermal Conversion of Solid Waste (SW)

The three principal methods of thermal conversion are combustion in excess air, gasification in reduced air, and pyrolysis in the absence of air[27]. However, the most common technique for producing both heat and electrical energy from waste is incineration. Thermal conversion technologies are commonly implemented in developed countries but scarcely used in developing countries due to the high construction, operation, and maintenance costs involved[27].

a. Incineration

Incineration is mainly the waste destruction in a furnace by controlling combustion at high temperatures to produce steam which in turn produces power through steam turbines[27]. By incinerating waste, approximately 70% of the total waste mass and 90% of total volume can be reduced[27], which leaves a small residue of waste to be disposed of in a landfill and thereby reducing the pressure and demand for landfills.

Incineration is particularly appropriate for the treatment of certain hazardous waste (medical waste), where the high temperature will destroy disease causing pathogen and toxins[27]. Waste incineration is popular in countries such as Japan where there is the scarcity

of land for landfilling, while Denmark and Sweden have been using the energy generated from incineration for many decades[27].

However, a World Bank report on MSW incineration indicates that MSW incineration plants tend to be among the most expensive WM options, and also require highly skilled personnel and careful maintenance[27]. The World Bank, thus, advises that incineration should be the desired choice only when other, simpler, and less expensive choices are not available. Consequently, incineration plants have been shut down in many cities around the world, including Buenos Aires, Mexico City, Sao Paolo and New Delhi, due to their high repair and maintenance costs[6].

Nonetheless, incineration is widely practised in some industrialised countries (as shown in Table 2.3) and only used to burn medical waste in some developing countries such as Ghana, because there is a high failure rate of incineration implementation in African developing countries. For instance, a waste-to-energy (WTE) incinerator which was recently installed and commissioned in Tanzania, with the support of international experts has failed. The high maintenance and operation costs of the incinerator are the reasons for the failure of this project.

Additionally, related environmental problems such as air pollution are a major hindrance to incineration globally[25]. There is usually widespread resistance to the setting up of incineration plants near human settlements because of the potential air pollution effects on residents near the plants. This would be especially precarious in most developing countries where there are weak legal regimes and poor environmental governance.

Table 2.3: The Proportion of Incineration of MSW in some Developed Countries[14]

Country	Population (Million)	Community Solid Waste (million tons)	The Number of Waste Burning Plants	The share of Burning Waste (%)
Switzerland	7	2.9	29	79
Japan	123	44.5	1900	72
Denmark	5	2.6	32	65
Sweden	9	2.7	21	59
France	56	18.5	100	41
Holland	15	71	9	39
Germany	61	40.5	51	33
Italy	58	15.6	51	17
USA	248	180	168	16
Spain	38	11.8	21	6
England	57	35	7	5

Source: [14]

Nevertheless, energy recovery from incineration of MSW has been practiced in many developed countries such as Japan for decades in an effort to promote SD initiatives[28]. Incineration does not only reduce the quantities of MSW but can provide alternative sources of energy. Therefore, it is obvious that the adoption of incineration - be it small or large-scale - in some developing countries such as Ghana is inevitable soon, because energy from incineration can contribute to the reduction of the current high-power deficit which is affecting economic development in these countries.

For instance, for the past ten years, Nigeria has not had a regular supply of power for both domestic and industrial purposes. The country has been depending largely on hydro for

her energy needs, however, due to climate change, the water level in the hydro dams over the years has reduced substantially, resulting in the two hydro dams generating about half of their generation capacity. Thus, incineration of waste can produce an alternative source of energy for Ghana and other developing countries.

b. Pyrolysis and Gasification

Pyrolysis and gasification represent refined thermal treatment methods as alternatives to incineration and are characterised by the transformation of the waste into product gas as an energy carrier for later combustion in, for example, a boiler or a gas engine[27]. These methods exhibit several potential benefits over traditional incineration[29]. For instance, in terms of emissions pyrolysis/gasification-based WTE technique enables a decrease in dioxins and NOx emission[27].

In the pyrolysis process, thermal decomposition takes place in which biomass is heated to a temperature from 400 °C to 550 °C in the absence of oxygen to produce char, non-condensable gases and vapours or aerosols[27]. An external heat source is usually required to maintain this temperature[13]. Pyrolysis of raw community waste typically would require some mechanical preparation and separation of glass, metals and inert materials prior to processing the remaining waste[13].

Also, in general, pyrolysis processes tend to prefer consistent feed stocks, and there is a very limited track record of commercial scale pyrolysis plant accepting community derived waste in the world[7]. Therefore, MSW is usually not appropriate for pyrolysis, though the process can be applied on MSW to produce fuels such as charcoal and coke produce gas.

On the other hand, gasification, also known as indirect combustion, is the conversion of SW to fuel or synthesis gases through gas forming reactions[27]. It can be defined as a

partial oxidation reaction of the MSW in the presence of an oxidant, thus creating the syngas instead of combustion gases as seen with incineration[27]. Gasification can be considered as a process of pyrolysis and combustion because it involves the partial oxidation of a substance.

The main product of gasification and pyrolysis is syngas which has a calorific value, and so can be used as a fuel to generate electricity or steam or as a basic chemical feedstock in petrochemical and refining industries[27]. The development of pyrolysis and gasification technologies for commercial and prepared community waste is becoming an established form of technology in the UK[27]. However, for MSW treatment these technologies are confronted by challenges such as operational inexperience, high costs, lack of financing, and concerns about toxic emissions[26].

Nevertheless, pyrolysis and gasification are promising alternative solutions for overcoming MSW treatment challenges and the increasing global energy demand[27]. The demand of finding low carbon energy technologies for the future world calls for the adoption of gasification and pyrolysis technologies to reduce carbon footprints in MSW treatment, although, lack of financing and high operation and maintenance could deter most developing countries from exploring their feasibility.

c. Waste-to-Energy (WTE) Technologies

The utilisation of MSW for energy production has been implemented globally for many decades[27]. There are three fundamental types of WTE technologies: thermal conversion; biochemical conversion; and physio-chemical conversion[13].

MSW is a source of renewable energy due to its composition. Renewable energy has attracted a growing attention due to global warming and rapid depletion of natural resources[7]. The fraction of MSW typically treated in a WTE unit is the unsorted residual waste (URW),

that is, the residual from the operations of source separation and collection of dry recyclable and wet organic fractions[7]. These WTE technologies are the same as the bioconversion and thermal conversion processing and treatment methods except for the physiochemical conversion method.

d. Physiochemical Conversion

The physiochemical technology involves various processes to improve physical and chemical properties of MSW[27]. In this process, the combustible fraction of the waste is converted into high-energy fuel pellets which may be used in steam generation[27]. Usually, the waste is first dried to bring down the high moisture levels, sand, grit, and other incombustible materials are mechanically separated before the waste is compacted and converted into pellets or refuse derived fuels (RDF)[27]. Fuel pellets have several distinct advantages over coal and wood because it is cleaner, free from incombustible, has lower ash and moisture contents, is of uniform size, cost-effective, and eco-friendly[27].

Most local communities in developing countries depend on wood and charcoal for cooking. For instance, the main sources of fuel for cooking for most households in the community in Nigeria are charcoal and wood. Also, a huge quantity of wood is also used in the brewing of a local beer '*pito'* in most parts of northern Ghana. The use of wood and charcoal for cooking and heating in some small-scale industries in Nigeria is aggravating deforestation with its well-known climate change effects. Thus, physiochemical conversion of MSW can produce fuel pellets to replace firewood which is commonly used in cooking in Africa and other developing countries.

Notwithstanding, waste technology is considered as one of the optimal methods for solving the WM problem in a sustainable way, it has a poor historical image in most

countries[7]. The reason for this is because many countries have depended on landfills for many years, and due to the fact that many of the earlier W technologies such as incineration were disposal-only plants, which simply burned waste to reduce its volume[27].

As a result, there is strong opposition to the continuous implementation of W technologies in some parts of the world. The zero waste movement (ZWM) in the US, for instance, argues that W technologies in the marketplace are actually waste of energy, money and natural resources[27], because of the high capital, operation and maintenance costs involved with these technologies.

Similarly, other critics are of the view that W technologies make no sense economically, environmentally and socially as it has the most GHG per fuel type, its emission produces dangerous air pollutants, it has the most expensive form of electricity, and it fails to create a fraction of the jobs created by recycling and composting[10, 27]. However, the benefits of W technologies are overwhelming as energy is not only recovered from waste, but also the amount of MSW to be landfilled is reduced drastically. Table 2.4 illustrates the global application of WTE technologies.

Table 2.4: Globally Application of Waste Technologies[27]

WTE Type	Application	Region
Incineration & Combustion	Only Heat	North America
Pyrolysis	Only Electricity	Europe
Gasification	Combined Heat & Power	Asia Pacific
Plasma Arc Gasification	Transport Fuels	Middle East & Africa
Anaerobic Digestion	Gas for Power	Latin America

Source: [27]

e. Sanitary Landfilling

Landfilling is sometimes regarded as a WTE technology when energy recovery is incorporated in its design, construction and operation. A sanitary landfill as a contained and engineered bioreactor and attenuation structure, designed to encourage anaerobic biodegradation and consolidation of compacted refuse materials within confining layers of compacted soil[27].

In general, sanitary landfill structures can be broadly separated into three categories: anaerobic, semi-aerobic, and aerobic, depending on the amount of air introduced into the waste layer[26]. Among these, it was indicated that semi-aerobic landfill systems are widely used globally[26].

Sanitary landfilling is the most customary means of MSW disposal globally and is the most cost-effective system of SW disposal in developing countries, as 65 to 80% of collected MSW is disposed of in landfills in developing nations[26]. In an evaluation of different MSW disposal methods, it was observed that composting of SW costs 2-3 times more than sanitary landfill, and incineration costs 5-10 times more[26]. Therefore, landfilling is not the most preferred option only in developing countries but all over the world today due to its high energy production potentials[29].

Despite this, the problem of leachate and gas (especially methane) emissions are difficult to mitigate during the operation and decommissioning stages of landfills. Although technology has improved to trap methane for useful purposes, leachate from medical waste management landfills is inevitable no matter the type of liner system used. Leachate contains various contaminants at concentration levels that may have environmental impacts on ground and surface water and can, therefore, be a threat to human health.

As a result, the role of landfilling has been rapidly diminishing in some developed countries waste management in recent years. For example, it was indicated that between 2006 and 2014, the number of operational landfill sites in the UK declined at an average rate of 6% per annum[9]. This declining number of active landfills shows that there has been a monumental and broadly positive shift in the UK waste management in a relatively short space of time, with higher levels of recycling, and the rise of energy from waste moving material up the waste hierarchy[9].

However, the reduction of operational landfills is not limited to the UK, but across Europe in compliance with the EU directive of diverting waste from landfills. Nevertheless, sanitary engineered landfills are the best disposal option in most developing countries and are in operation in some African countries, including South Africa, Botswana and Zimbabwe[9], with environmental impacts properly mitigated, despite that, most landfills in other developing countries are not engineered and are mostly covering by refuse waste in the dump sites neither with proper technical input or with treatment of the emerging emission to water, air and soil[9].

Developing countries, especially sub-Saharan African countries, need to convert their numerous open dumps into sanitary landfills and possibly incorporate energy recovery in the landfill designs to benefit from the energy potentials of landfilling to supplement their energy needs. Sub-Saharan African countries are currently facing energy crisis with many areas without access to electricity. Therefore, energy recovery (methane) from waste can play a role in minimising the impact of MSW on the environment, unemployment, and provide an alternative source of energy for economic development.

2.1.5 Methods of Disposal of Solid Waste

1. Current Methods of Disposal of Solid Waste

A study on an analysis of waste generation in a traditional African city: Ogbomoso, Nigeria showed that, several regions in the country use various means of waste collection initiated by both public and private sectors, although the effectiveness of this is largely a function of location[31]. Where the collection is done by private sectors, it is a function of income of the owner of the waste to be able to pay the amount charged. Several systems of waste collection in Onitsha, though modern waste management systems were still solicited for. Another study showed poor waste management practices among residents of Owerri Community indicated that respondents practiced open dumping while others preferred to burn their wastes[29]. These are not ideal since they constitute potential sources of infection, air pollution as well as constitute aesthetic blithe. In a related study, showed that majority of the respondents in Awka disposed their waste through government waste management agency and only few dumped theirs in unauthorized area[25]. This is an indication that the community members enjoy the benefit of existing strong and functional government waste management agency. A number of other studies in Nigeria and South Africa shown that majority of the respondents have a centralised place for dumping waste and the commonest means of transports of waste was by wheel barrow[25].

In many cases non organic waste is improperly disposed because it does not decade or rot to produce stench. These mainly include; broken bottles, polythene bags, metallic material, and other forms of fiber. Such waste is normally thrown in pit latrines or unused areas. Whole bottles are sold. Plastic bags are burnt. Less than 1% of the households reported selling broken bottles[25]. The main reasons for this are that the quantities are too small to be

traded and households do not know where to sell them. This practice is done because the community members are not aware of the dangers and the consequences of this bad practices couple with bad attitude towards the practices of waste management. A number of studies found that the most popular methods of waste disposal known to the respondents were open dumping followed by burning while the least known method was incineration. This scenario is not very different from findings in other studies. Open dumping remains the simplest and the most commonly used method for disposing waste[25]. In most low to medium income developing nations like Nigeria, almost 100 percent of generated waste goes to landfills[29]. In spite of the recycling and composting of greater amounts of waste in the United States in the last couple of years, the majority of waste generated still end up in landfills. While wastes are deposited in open dumps in developing nations; these have become obsolete in the developed countries. Sanitary landfills which are well engineered facilities (with liners, leachate collection/ treatment system, and gas collection system) are now used to ensure the protection of human health and the environment[29]. These modern landfills are often under strict federal and state regulations and are therefore specially sited, designed and operationalised to ensure environmental performance[25].

However, it is different in some parts of Nigeria, where the unsanitary landfills are not subject to regulations, and are usually sited for convenience, such as the presence of a pre-existing hole (created from sand mining activities) into which waste could be deposited[26]. Also, in Lagos, Nigeria, some of these open pits are located near residential housing and therefore represent a threat to human health and the environment[3].

A study showed that the major type of waste generated from households was food residues 271 (97.1%), followed by vegetable 269 (95.4%) [32]. A study on household waste

management in Awka found that the commonest type of waste generated was garbage (100%), followed by cellophane bags (99%) [25].

Availability of Dustbins

A study explored the two major ways in which waste can be sorted and recycled at the household level into different bins in accordance to the rules of waste management, when household are required to sort waste into a given number of categories, or in specialised sorting facilities[10]. It was found that most respondents preferred to sort waste themselves if given the choice but they do not have the bins for sorting or they cannot have access to waste management bins. The knowledge of participants did not lead to practice, so 66% of them did not segregate the wastes in differences bins[29].

Communities in developing countries often turn to waste disposal methods that have proven to be destructive to human health and the environment, such as open dumping and burning (or unregulated landfills) because they feel they have no other options to manage their waste because they do not have the bins for putting the waste[24]. Some households practice waste separation into different types of bins before disposal in different garbage bags (some of the separated waste is put in different corners not necessarily in plastic bags/bins or containers) [25]. Waste is not separated after it is mixed up. Items which are thought that can be re-used or recycled are not mixed with the rest of the garbage. However, those households with adequate space normally throw waste in the backyard and remove plastics when the garbage is dry.

In a study it was found out that, households mostly separate banana and potato peelings (81.7%), broken and whole bottles (18.3%), and plastic bags (17.6%) [33]. The bottles do not include beverage bottles (beer and soda) because households do not consider them as

waste. The banana and potato peelings are either sold to urban farmers, or given out in exchange for taking away the waste. The peelings are also sometimes fed to their own animals. Only 4.7% of the households put the peelings in a pit[33]. The separation of peelings and making good use of them is a sign that with time there will be no peelings in the waste streams.

2. Dumping of Waste in Drainage System

Open dump of waste especially in the drainage is a common practice in Nigeria. While some employ the service of streams to transport their wastes out of their sight, some directly dump their wastes by the road sides or the tunnels in a drainage lines[33, 34]. Several Nigerians have considered it a cheap way of disposing off their wastes by setting the mixed wastes on fire in a little corner in their backyard or in a very open place or putting them on the drainage system.

3. Keeping of Waste where People Live/Stay and Storage of Solid Waste

Recent research on environmental concern and its implication to household waste separation and disposal in Ethiopia shows that a proper understanding of the relationships that exist between the environment, waste separation and disposal can contribute to good waste management and therefore, a cleaner and healthier environment[5]. There are a number of factors that have been found to contribute to individual's behaviours concerning waste. The education level of household members, shorter distance to waste containers and household income are found to increase the probability of proper disposal of waste into containers [33, 36].

One common method that city households in developing countries use to get rid of their wastes is dumping in an unauthorised area and sometimes keeping with them since their

disposal method is unlawful. This is done to allow them disposed it at a wrong place when the authority cannot see it[33]. Human wastes are great contributors of environmental health hazards. About 1.3 billion tons of waste are generated globally, 0.035% being generated by Nigeria. About 85.8% of Nigerian waste is generated by households[33, 34]. It is estimated that an average Nigerian in the urban or rural areas generates about 0.49 kg of waste per day with household and commercial centers contributing almost 10% of total urban waste burden[33]. Of this about two thirds of wastes are dumped indiscriminately on the streets and in the drains thus posing serious environmental health hazards[34].

In practice, waste management interacts with city planning fundamentally from the source of waste generation: people and built environment. City planners' involvement in waste management, however, has been largely limited to the environmental field, with a focus on facility siting in particular[33]. In other words, waste management is commonly perceived as the "end-of pipe" of socioeconomic activities.

2.1.6 Role of Authority

Traditionally, the communities have been in charge of providing WM services in developing countries[24]. Responsibility is to organise and manage the public sanitation system, including providing the infrastructure for the collection, transportation, treatment and disposal of wastes. However, with ever increasing population and economic growth, many communities in developing countries are struggling to keep WMS working in a sustainable manner. Often they are ill managed or even cease to exist because of various social, institutional, and technical constraints which have resulted in hygiene and sanitation related diseases; such as diarrheal diseases[6].

The waste management systems originated from the ancient times, with the first attempt to manage wastes by Greeks taking place in A.D, 4thcentury[35]. The challenges the Greeks faced encompasses high population growth, limited space, hygienic complexities among others making the waste management system alignment difficult. The collection and transportation of wastes form the basic practices in waste management[36].

With the rapid urban development and corresponding escalation in population size, the sanitation conditions worsened as garbage wastes formed the dangerous threat on human health as well as the environmental hygiene to the inhabitants of these places. In the 14th-16th century, vermin perpetrated the plagues in Europe, especially in urban unsanitary environments. At around this time, development of waste management approaches occurred, with the aim of combating disease spread despite the political and social limitations during the time[36]. As a means to deal with and manage wastes, communities in developing countries often turn to knowledge, attitude, practices, disposal techniques of waste (open burning and dumping) as the only option to handle waste materials and promote good hygiene and human health[24]. As the priority in many developing nations to deal with increased industrial waste, attitude, practices, and knowledge as well as waste type, urbanisation form instrumental variables in waste management[25].

2.1.7 Waste Management: Problems and Challenges

Waste management is the most important issue that starts from its generation to the handling effects and creates worries to man[23]. Waste which is a by-product of human and animal activities and the most common waste within man's environment can be very hazardous and dangerous if not properly taken care of. Heaps of waste disposed

indiscriminately in different areas of the environment such as the recreational sites, roads, alleys and even markets are being fed up by rats and houseflies which can serve as host of transmitting diseases to man directly and indirectly, thereby threatening human health[26]. A research conducted on the process of managing waste the following problems and challenges especially in developing nations were identified lack of comprehensive legal framework and enforcement of the existing regulations; low investigation in infrastructure; inadequate human capacity of administrative and technical issues; wrong attitude of the public towards waste disposal; financing cost recovery is low in most area and in some no funding; poor planning: low data management and uncontrolled urbanization uncoordinated institutional functions; low academic research and industrial linkages; and lack of the needed political will[37]. The problem of waste management has become a debilitating factor towards sustainable development in all countries of the world especially as it concerns human health[38].

2.1.8 Management of Solid Waste (MSW) Collection

Waste collection is the gathering of waste management from the point of production (residential, industrial, commercial, and institutional) to the point of treatment or disposal[35]. Waste collection is the main component of waste management that links waste generators to the waste management system[36]. Typically, the collection is the costliest and fuel intensive component in the WM system[37]. It also defines the initial separation of materials which affect all downstream processes. There are several ways of waste management collection, however, the common methods of waste collection are:

a. **House-to-house:** waste collectors visit each individual house to collect garbage. The user generally pays a fee for this service;

b. **Communal Collection:** Users bring their garbage to community containers/bins that are placed at vantage points in a neighbourhood or locality. Solid waste is picked up by the community, or it's designate, according to a set schedule;

c. **Curb-side Pick-up:** Users leave their garbage directly outside their homes according to a garbage pick-up schedule set by the local authorities;

d. **Self-delivered:** Generators deliver the waste directly to disposal sites or transfer stations, or hire third-party operators; and

e. **Contracted or Delegated Service:** Businesses hire firms (or community with community facilities) who arrange collection schedules and charges with customers. Communities often license private operators and may designate collection areas to encourage collection efficiencies[35, 36].

The effectiveness of these collection methods depends on other urban infrastructure such as well-planned settlements and good road network. However, due to the high infrastructure deficit in most developing countries, the communal collection is the most popular method of collection. For instance, in Ghana curb-side and house-to-house collections are limited to the high-income residential areas where there are goods roads and the residents can afford to pay for the service, while the middle and low income areas rely on communal collection and improper waste disposal practices such as throwing waste into drains, bushes, and burning[1].

SW collection is a public service that has important impacts on public health and the appearance of towns and cities, and forms about 85 percent of the total cost of waste management systems in most countries worldwide[36]. The failure of many authorities in developing countries to consider important parameters of each particular location in the

purchase of solid waste management collection equipment has led to many failed collection systems and the wastage of huge sums of money[35]. In many cases, collection vehicles and containers have been purchased in large numbers in some developing countries, but they have not been effective and have been operational for only short periods that are much less than their expected design lives[35].

The purchase of unsuitable equipment in some cases is attributed to corruption and the assumption that the same type of waste collection equipment will work effectively in any situation[37], without considering the specific contextual circumstances of the local situation and waste characteristics. Many other factors act against effective SW collection in urban areas of developing countries, some of which are traditional values and religious beliefs[37, 38]. For instance, it is widely believed in India that works requiring direct contact with SW is strictly for the lower classes[38].

In an effort to ensure effective waste collection, there has been a trend towards privatisation of SW collection in many cities in developing countries since the 1980s[33, 34]. There are cases in which the private sector has succeeded in providing a good SW collection service in cities where the public sector had previously failed, but it is more common to find that, where the public sector (local government) has failed, private enterprise also fails to deliver the required service[33, 34], especially where the private sector enjoys monopoly in most developing countries, it becomes worse than the public sector.

However, the engagement of the private sector in the waste collection through competition, transparency, and accountable processes has drastically improved SW collection in some developing countries[29].

2.1.9 Management of Solid Waste Disposal

In the past, the disposal of wastes did not pose a significant problem because the population was small and the amount of land available for assimilation of waste was large[5]. However, the need for adequate treatment and disposal of waste by man arose as populations moved away from dispersing geographical areas to congregate together in communities[29].

Thus, safe disposal of waste is now a global norm, though, solid waste treatment and disposal is still a neglected area in many developing countries. Improper disposal of solid waste in developing countries are manifested in the dumping of solid waste into water bodies and wetlands, and the burning of waste to reduce its volume[24]. These practices are known to have adverse environmental impacts ranging from polluting natural resources and the ecology to the creation of health problems, which might lead to long-term public health complications, causing a public nuisance, and degradation of the environment and aesthetics.

Nonetheless, inappropriate disposal of waste is not only peculiar to developing countries, as the practice has occurred in every country at a point in time. In the past there were no ways of dealing with solid waste that have not been known for thousands of years[24]. These ways are essentially four: dumping it, burning it, converting it into something that can be used again, and minimising the volume of material goods and future garbage that is produced in the first place.

Thus, every country at one point in time has been confronted with the challenge of improper waste disposal. For instances, there were reported cases of cholera outbreaks in the UK in the 1950s and 1960s due to poor sanitation, including solid waste management[9].

Presently, open dumping of waste is the norm in Nigeria, Ghana and other developing countries[24]. Open dumping is an illegal process, in which any type of the waste such as

household trash, garbage, tires, demolition/construction waste, metal or any other material is dumped at any location such as along roadsides, any available space either public or private property other than a permitted landfill or facility[30].

Open dumps are simple open sites with no engineered measures and no consideration for leachate and landfill-gas controls. They have devastating effects on the environment with long-term impacts such as pollution of air, soil, surface and groundwater.

Accordingly, landfilling is the most recommended method for MSW treatment and disposal in developing countries because it is the simplest and normally cheapest method for disposing of waste[12, 31]. Hitherto, the main considerations in the design, construction, operation and decommissioning of landfills, which are emissions control and groundwater pollution prevention, are often ignored due to the high capital cost and lack of technical skills needed for landfilling in some developing countries[31]. Therefore, un-engineered landfilling, which is a disguised open dumping, is the practice in most developing countries.

Despite that a lot of significant efforts have been made in the last few decades in many developing countries, through technical and financial support from some developed countries and international organisations, substantial reforms in the disposal of MSW are still not attained[31]. This failure can be attributed to the absence of the enabling environment for WM such as waste management governance (policy, legal, institutional, and financing frameworks) and adequate technical capacity, which is a sustainability element needed to ensure sustainable waste management[31].

2.1.10 Sustainable Waste Management

Waste is no more treated as the useless garbage with no intrinsic value, rather waste is considered as a resource in the present time[26]. Resource recovery is presently the important focus in the design of most waste management systems. Consequently, waste reduction and waste separation are the two important components of resource recovery from waste and sustainable waste management[26]. These actions are apparently impossible to implement without high consciousness within the communities as well as a strong commitment and support from waste management authorities.

For several reasons, resource recovery is a major element in waste management in most developing countries[32]. Reclaimable inorganic components (metals, glass, plastic, textiles, and others) traditionally have been recovered mostly by way of unregulated manual scavenging by private individuals (informal sector), however, waste reduction and waste separation are rarely practiced by households of waste management authorities' due to poor waste management governance, which is militating against sustainable waste management in most developing countries[33].

Most developing countries in an attempt to accelerate the pace of their industrial development have failed to pay adequate attention to sustainable waste management[33]. This has led to severe penalties in the form of resources needlessly lost and a staggering adverse impact on the environment and on public health and safety[33].

Thus, every country needs to adopt appropriate waste management systems that meet their needs at every level of development in order not to pass on waste management challenges for future generations to solve. Appropriate planning is key to sustainable

development in the waste sector through the development of sustainable waste management infrastructure and systems[33].

Planning is the first step in designing or improving a waste management system, however, in most developing countries, planning is ignored and ad-hoc measures are used to only get waste out of sight[33]. Nevertheless, planning is required to balance the social, economic, political, governance, environmental and technical considerations for waste management, because waste management planners are faced with a system that involves a variety of these factors[32]. Therefore, in making decisions, the trade-offs among these factors are a central concern.

The cornerstone for planning for waste management is reliable baseline information of the waste generation and characteristics. For instance, the baseline information of the waste generation and characteristics will assist in the formulation of targets for waste reduction and material recovery[33].

However, unfortunately, SW planners in most developing countries do not have the resources and the expertise needed to analyse all the information that is relevant to a proposed waste management policy[32]. In most cases, only the financial cost borne by the community is considered, effects on air and water, and environmental equity are only considered when a crisis with the public develops, or when regulations are imposed[31, 32].

The key role of waste management planning is to establish which combination of waste management strategies and methods will ensure sustainable waste management. Therefore, in planning for waste management, the objectives must be sustainable and realistic, consistent with the environmental policies and regulations and measurable so that progressive achievements are verifiable[33].

Accordingly, sustainable waste management has been achieved through various concepts/strategies for waste management in many parts of the world (particularly in developed countries). These strategies are based on waste reduction strategies and/or a combination of various waste management technologies. The following subsections discuss some of the applicable concepts/strategies for the achievement of sustainable waste management.

2.1.11 Waste Management Practices in Developing Countries

Waste Management involves the collection, storage, transportation, recovery/recycling, processing, treatment, and final disposal of waste. The collection, transport, treatment, and disposal of Solid Waste, particularly waste generated in medium and large urban centers, have become a relatively difficult problem to solve for community authorities in developing countries who are solely responsible for waste management[13]. The problem is getting acuter in these countries because financial, human, and other critical resources generally are scarce.

Also, the waste management situation in some developing countries is getting worse, because research into waste management has often focused on industrialised nations, with only a few studies focusing on providing information that is required in developing countries[34]. Subsequently, in some developing countries, there is a growing concern of inadequate management of waste, particularly in urban areas where the consumption patterns have changed and the generation rate has increased substantially[13].

The challenge of waste management for the cities' authorities in developing countries are mainly due to the increasing generation of waste, the burden posed on the community

budget because of the high costs associated with its management, the lack of understanding of a diversity of factors that affect the different stages of waste management, and linkages necessary to enable the entire handling system functioning[34]. While systems analysis largely targeting well-defined, engineered systems have been used to help WM agencies in industrialized countries since the 1960s, collection and removal dominate the WM sector in developing countries[13].

It is common for communities to spend 20 to 50 percent of their available recurrent budget on WM, while 30 to 60 percent of all the urban SW remains uncollected and less than 50 percent of the population is served[30]. This compels community authorities to concentrate waste collection services in the high-income residential areas where the residents are more vocal in complaints about poor collection services to the detriment of poor and slum dwellers[34]. Like most environmental hazards, deficiencies in waste management unduly affect poorer communities as waste is often not collected or dumped in land near slums.

Nevertheless, the management of solid waste is not just a public service but also an important economic sector which can provide business and job opportunities[31]. It was contended that the sector is worth USD 390 billion in both OECD and emerging countries and provides up to 5% of urban jobs in low-income countries[31]. Similarly, it was indicated that there is a potential global school of almost a trillion dollars in food waste and food loss alone[34]. The global management of solid waste production is projected to double in the next five years[34], while this increase in management of solid waste production will result in management challenges in developing countries, it equally presents an opportunity for community authorities and private sector to harness for sustainable development.

Therefore, the waste sector, with all its complexities in developing countries, has a lot of potentials to be organised in a way that is more economically, environmentally, and socially sustainable[34]. Improved waste management approaches can generate economic growth through the creation of new business and employment opportunities for the teeming unemployed youth in most developing countries. Also, proper waste management can facilitate the recovery and reuse of valuable resources and a corresponding reduction in the depletion of virgin materials[35].

Despite the possible benefits of waste management, many developing countries do not have the needed technological know-how to harness the opportunities that come with the high volumes of generated solid waste[35]. The focus of waste management in developing countries has largely been limited to improving the environment, however, waste management can provide direct health benefits, support economic productivity, and provide safe, dignified and secure employment opportunities.

2.1.12 Pre-Service Teachers

Teacher education is a programme related to developing teachers' proficiency and competence to empower them to meet the profession's requirements and face the challenges therein[39]. It encompasses teaching skills, sound pedagogical theory and professional skills. In Nigeria, teacher education programmes are offered at pre- and in-service levels by different teacher education institutions such as Grade II teachers colleges, Colleges of Education and Universities' Faculty of Education.

Pre-service teaching is a period of guided, supervised teaching. The college student is gradually introduced into the teaching role for a particular class by a mentor or cooperating

teacher. The cooperating teacher encourages the pre-service teachers to assume greater responsibility in classroom management and instruction as the experience progresses. The pre-service teacher begins as an observer and finishes the pre-service teaching experience as a competent professional[40]. Pre-service teaching is an essential experience in the professional education programme[39].

Teachers can promote environmental literacy by interacting with society (specifically learners, parents and colleagues). Teachers can hardly assist learners in becoming environmentally literate if they lack environmental literacy. Despite the critical role the teachers play in educating students, research into teachers' level of environmental knowledge has been extremely limited. Pre-service teachers need education in the subject matter and pedagogically appropriate to environmental education to achieve the competencies of an environmentally literate teachers and professional competencies of an environmental educator to play a crucial role in developing environmental literacy in future generations[41].

Therefore, teachers are the most important factor in achieving environmental education objectives; they are crucial in developing positive attitudes toward the environment, environmental knowledge of waste management in students[42]. A teacher who has environmental awareness and positive environmental attitude will be able to practice and teach students appropriately about the environmental knowledge, attitude and practices on waste management[43, 44].

2.1.13 Environmental Knowledge

The knowledge possessed by a community refers to facts, information, and skills acquired by a person through experience or education. The theoretical or practical understanding of management of waste. The environmental knowledge can be seen as the

levels of education, health education and sensitisation about waste management, sources of information about waste management and awareness of environmental laws regarding waste management[44].

Environmental Knowledge about waste management is highly influenced by participating in the health education sessions[44]. Increases in knowledge about types of diseases spread and types of hazardous waste are particularly pronounced among health educated population compared to groups without health education.

In sub Saharan Africa, community participation in waste management is mostly informal and there are no clear avenues for active formal participation. Waste pickers work in informal groups with no clear control and do not follow safety and health regulations. The councils are also unable to enforce existing waste management laws because of lack of resources and political interference[24]. People's perceptions and attitudes towards waste management are that it is the sole responsibility of urban councils and that being a waste worker is socially degrading. Most recyclers are more likely to get one or more sources of information for example friends, newspaper, television, etc. Various sources of recycling knowledge coming from public education and information through public campaigns are expectedly showing a positive correlation with recycling rate[10].

In Uganda many community members in slum areas are not aware of modern recycling method. Few of them know that, recycling and reuse may reduce the use of raw materials and energy, and minimize the footprint of production and consumption[45]. However, it has only achieved limited success in the U.S[45]. As demonstrated in a cost-benefit analysis of waste management options, waste management policies are largely designed on the basis of economic considerations.

To effectively achieve sustainable behaviour change it is necessary to understand how the public values, perceives, and behaves in relation to environmental change and cleanliness. It is for this reason that knowledge, attitudes, and practices (KAP) approach is particularly useful for this research. KAP research approaches are used to understand what people know, believe and do in relation to a specific topic[46]. In health research, this is particularly valuable as understanding the knowledge, attitudes, and practices of a community can provide data on how to improve quality and accessibility of services, current health and cultural practices (like seeking medical attention, exercising, keeping the environment clean among others), and opinions of a particular health outcome[28]. Understanding these issues is particularly important when making policy decisions that will be sustainable, appropriate, and accessible to the community. This knowledge will help the researcher target a population and understand what is culturally appropriate among pre-service teachers in the school so as to facilitate the implementation of an innovation to solve the problem of sanitation.

The concept of knowledge and associated relationship with environment has been a topic of interest among researchers for years. This has arisen as a result of the increasing need for cleaner and improved environment. Thus there is a constant search for a solution to sanitation and health problems. The global anxiety about high rate of waste generation has put waste prevention as a high priority on the waste management hierarchy. Reducing the amount of waste generated, can have practical advantages such as few collection trucks, personnel and waste handling facilities as well as longer life for the landfill sites if individuals have the right knowledge level about proper sanitation[44]. Further, the relevant knowledge will lead to a drastic decrease in related environmental problems that confront developing countries including Nigeria[34]. However, waste reduction seems to be very

difficult to achieve because it is much associated with changing people's knowledge level and attitude[46].

Local knowledge reflects local power and it is important in contributing to maintain the legitimacy of decisions[46]. It could be argued that local communities would not be able to function properly as community leaders if they do not gain the needed support from the broad masses of the people. In many parts of the world, communities continue to be looked at as passive recipients of government services, and are very often disregarded even in local decision-making process. Ultimately, this approach results in the people failing to know the role they can play in the process[46]. This goes to lend support to the argument the researcher is advancing to include directly pre-service teachers in the fight against poor sanitation in order to reduce waste in the school environs and improve sanitation.

It was concluded that the prevailing waste management strategies have failed to take notice of the local knowledge[47]. This has helped in compounding the waste management and scheme formulation problems instead of contributing to the solution of waste problems in Africa[28]. Waste separation is not common practice in the schools and in most African countries. It is still an area that requires a lot of enlightenment and education. Waste separation at source can enhance the homogeneity of the waste recovered to minimise its level of contamination. Knowledge of people on source reduction of waste is very low even though they showed a high level of awareness of recycling of plastic waste[45]. The knowledge possess by a community refers to the understanding of any given phenomenon, and so is the issue of sanitation at Schools. Differences however were observed in Port-Harcourt city residents' knowledge and practices of waste management.

Further, environmental issues should be the concern of all human beings, as the environment is their ultimate living space. In order to be able to deal with environmental issues and protect the environment, education is the best way[43]. Education about the environment can be designed for both formal and non-formal education as well as extra-curriculum activities. Similarly, it was emphasised that to improve people's environmental awareness, the school education curricula must cover environmental problems and issues[44]. Teachers are the important subjects in schools who can create better environmental knowledge in students' minds[43]. Before educating students, the teacher education programme itself should consider environmental education. In a research, the lack of environmental education for both pre-service and in-service teacher education was emphasised[44]. The importance of environmental education, is to emphasise that education about the environment can improve awareness and build positive attitudes toward the environment. In this view environmental education in teacher training programmes is essential.

Also, science teacher education plays a big role in students' learning of environmental issues[46]. Since concepts about nature are covered in science lessons many journal authors focus on present and future science teachers. Also, science teachers have a big responsibility to sustain environmental education in schools. However, it was stated that all teachers, regardless of their subject area, should know environmental concepts so that they are able to be good role models to their students[43]. For example, it was claimed that education about environment and environmental issues both in schools and out of schools during informal education, is a very helpful way to increase environmental awareness and consciousness of youth[43]. Also, environmental education should be started in primary school

and continue to the university level, in order to give a continuity of environmental education making it possible to have environmentally-minded people in society.

2.1.14 Environmental Attitude

In psychology, attitude is a mental position with regard to a state or fact. Attitudes reflect a tendency to classify objects and events and to react to them with some consistency. Attitudes are not directly observable but rather are inferred from the objective, evaluative responses a person makes[47]. Attitudes are formed as a result of this ongoing evaluative process. Attitudes also refer to a person's general feelings about an issue, object, or person. There has been a lot of literature on recycling of waste in developing and developed economies by researchers and institutions[45, 46, 47]. These studies have shown that attitude influences behaviour of people in taking decision on issues especially issues that concerns the environment; the knowledge, attitudes and practices of a community and found that changes in attitudes and practices tell what people know about certain things, how they feel and also how they behave. Attitude refers to the feelings towards the subject as well as any preconceived ideas that they may have towards it.

Attitudes are said to have a major impact on behaviour and one's ability to manage and adapt to change while also influencing the behaviours of others. People can change their mind towards a higher plane or a lower plane according to their attitude towards a given situation, person or place or a concept. Attitude is linked to our sense of belief and previous judgments. Attitude counts a lot in our individual and social life. We may say that our attitudes and inclinations are borne out of our experience or encounters with various aspects of life. Thus, ones' attitude cannot be changed so long as the experiences remain so[47]. Ever

since the beginning of attitude research, investigators have puzzled over the relation between attitudes and behaviour. For instance reasons that made people sometimes said they liked something and then acted as if they did not, such as the case where the media awareness creation about poor sanitation which the general public acknowledge, but do not practice proper sanitation in their surroundings.

To help improve the health of poor people across the world depended on adequate understanding of the socio-cultural and economic aspects of the context in which public health programmes were implemented[68]. Such information had typically been gathered through various types of cross-sectional surveys, the most popular and widely used is the Knowledge, Attitude, and Practice (KAP) [48]. Besides, attitudes were interlinked with the person's knowledge, beliefs, emotions and values, and they were either positive or negative. Causal attitudes or erroneous attitudes were considered derivatives of beliefs and/or knowledge. Investigators depended heavily on behavioural indicators namely, what people say, how they responded to questionnaire or such physiological signs.

2.1.15 Environmental Practices

Practices refer to the ways in which people demonstrate their knowledge and attitude through their actions. The practices of people about waste is using Landfill, which is the oldest form of waste treatment.

Environmental practice refers to the ways in which people demonstrate their knowledge and attitudes through their actions in the environment[48]. Unsanitary disposal of wastes is a major environmental concern in the world and the current legislation system of waste management practices require numerous improvements and modification in order to

meet the required standards. It is contended that such changes need to be accompanied by a community environmental education programme designed to improve citizens' knowledge, attitudes and behaviours[46].

A landfill site also known as tip, dump or rubbish dump was historically a maiden site for the disposal of waste materials by burial. Historically, landfills have been the most common methods of organised waste disposal and it has remained so in many places around the world. Landfills may include internal waste disposal sites where a producer of waste carries out their own waste disposal at the place of production as well as sites used by many producers. Many landfills are also used for waste management purposes, such as the temporary storage, consolidation and transfer, or processing of waste material sorting, treatment, or recycling[49]. Landfills are often established in abandoned or unused quarries, mining voids or borrow pits. A properly-designed and well managed site for landfill can be hygienic and relatively inexpensive method of disposing of materials. Older, poorly-designed or poorly-managed landfills created a number of adverse environmental impacts.

Wastes included industrial wastes, construction wastes, agriculture wastes, house garbage, sludge, excrements, and medical wastes and so on. These specifications were according to their desirability in terms of waste minimization. The waste hierarchy remained the cornerstone of most waste minimization strategies. The aim of the waste hierarchy was to extract the maximum practical benefits from products and to generate the minimum amount of waste. Existing final disposal sites for community waste were also not engineered and may be described as crude dumpsites. There was no waste separation at the source of generation and hazardous waste was often handled together with community waste[49].

2.2 Theoretical Review

Several theoretical frameworks are pertinent to pre-service teachers' environmental knowledge, attitudes and practices in the adoption of basic environmental sanitation behaviours. However, this study adapted Diffusion of Innovation (DOI) theory and Health Belief Model (HBM).

2.2.1 Theory of Diffusion of Innovations (DOI on KAP Model)

The rationale for adapting Diffusion of Innovation (DOI) theory[50, 51] is to illustrate how any new innovation moves from creation to widespread use or non-use. Innovation is an idea, practice or object that is perceived as novel by the individual, and diffusion is the process by which an innovation makes its way through a social system[51]. Innovations are, therefore, seen as a new concept or object that has to be shared among prospective adopters within a social system, and may be considered as a new thing by the potential adopters.

The fact remains however that there are established laws and formal governmental structures to address serious environmental problems but few have been successful in alleviating those problems. Regulations are the most common approaches to environmental problems. Standards, bans, permits and quotas are often favoured by planners because they promise certainty of outcome – without costly monitoring and enforcement, but this promise may not be realised. The innovation decision process, individual innovativeness, rate of adoption and perceived attributes are among the most important characteristics[50]. For instance the pre-service teachers can undertake the sorting out of waste into components before they are finally disposed of in the right bin.

Diffusion theory identifies numerous factors that facilitate or hinder the adoption and implementation of a new idea. These factors include characteristics of the new idea,

characteristics of adopters, and the means by which adopters learn about and are persuaded to adopt the new idea. Pre-service teachers' characteristics (for example, individual's age, gender, experience with plastic waste for disposal/management purposes and financial position) can influence the adoption of an innovation. Also, it can be said that there are two external attributes; the perceived usefulness and ease of use with regards to using sanitation facilities[73]. Environmental knowledge, attitudes and practices (system use) are other attributes that can affect pre-service teachers' desire to adopt improved ways of managing waste especially, plastic and nylon waste. These attributes of Diffusion of Innovation make it the most appropriate theory for this study environmental knowledge, attitude and practice among pre-service teachers since they are to adopt the new idea of sanitation in the waste management process.

Figure 2.3 below shows the way to encourage the basic sorting decision process using the innovation decision stages[50]. The innovation-decision process is an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation[51]. The innovation-decision process involves five steps: namely knowledge, persuasion, decision, implementation, and confirmation. The five steps are to end in taking a decision that ensures proper sanitation and environment through basic sorting which the figure below exemplifies.

Figure 2.3: Waste Bins for Ensuring that Sorted Waste is Properly Categorised

Source: [50]

The Innovation-Decision Process

The innovation-decision process according to the five ordered steps in relation to improving waste management are discussed in the order below:

1. **The Knowledge Stage**

At this stage, an individual learns about the existence of innovation and seeks information about the innovation. "What?" "How?" and "Why?" are the critical questions at the knowledge stage? During this stage, the individual attempts to determine what the innovation is, how and why it works. The questions that should be ask comprised of three types of knowledge: which are awareness-knowledge, how-to-knowledge, and principles-knowledge[51]. Awareness-knowledge: Awareness-knowledge represents the knowledge of the innovation's existence. This type of knowledge can motivate the individual to learn more

about the innovation and eventually, to adopt it. When pre-service teachers are aware of the relatedness of knowledge, attitudes and practices of environment and how it affects either negatively or positively their operations, livelihoods and health, it becomes imperative for them to concern themselves with the innovation. Pre-service teachers, who are socially aware, know where to go for support and resources and are sensitive to the needs and priorities of others thereby more likely to have a try to succeed.

Individuals who have technical backgrounds may not use technology, if they do not have knowledge of how to use it correctly[52]. An innovation in this case such as separating waste into different categories for instance plastic, organic food waste, paper and card, metal, glass and textile is essential. This implies pre-service teachers' management (school management) providing separate bins for the various wastes in the school, and teaching them to sort and deposit the waste into bins meant for each. The purpose is to make pre-service teachers put into practice the innovation since individuals need help on how to use the new idea effectively. In the management of waste, there will be the required innovation, but without knowledge, the facility will be there without any use or its use can become difficult for lack of the requisite human environmental knowledge, attitudes and practices. The pre-service teachers, who do not have knowledge about how to sanitarily manage waste, may not attempt to do so[46]. The researcher reasons that if pre-service teachers acquire the relevant knowledge it will help shape their attitudes and this will lead them put into practice measures that deal with the problem of waste management, especially that of plastics and nylon littering classrooms.

An innovation may be adopted without this knowledge, but the misuse of the innovation may cause its discontinuance. For pre-service teachers it is crucial that they have

this knowledge of the innovation due to the salient role they will play in transferring of knowledge to their students in the future. Pre-service teachers need to know how to effectively manage waste through acquiring the needed level of knowledge, displaying the right attitudes and sound practices of and towards waste in order to effectively apply it in their daily activities and help other people learn and help in the management of waste. To create new knowledge, awareness education and practice should provide not only a how-to experience but also a "know-why" experience. An innovation in this case such as separating waste into different categories for instance plastic, organic food waste, paper and card, metal, glass and textile is essential. This implies management should provide separate bins for the various wastes in the school, and teaching them to sort and deposit the waste into bins meant for each. In the management of waste, there will be the required innovation, but without knowledge, the facility will be there without any use or its use can become difficult for lack of the requisite human knowledge, attitudes and practices. The pre-service teachers, who do not have knowledge about how to sanitarily manage waste, may not attempt to do so.

2. The Persuasion Stage

The persuasion stage occurs when the individual has a negative or positive attitude toward the innovation. Although, pre-service teachers may be equipped with knowledge and skills in handling materials and other waste, the success of implementing the new idea (sorting waste into different categories) with sanitation education depends greatly upon the attitudes of the pre-service teachers and their willingness to embrace such innovation[44]. In view of this, pre-service teachers should possess not only proper knowledge and skills of sanitation, but they must also have the right attitudes toward it. An individual's knowledge

about an innovation shapes his or her attitude towards an innovation. The knowledge stage is cognitive (knowing) centered, the persuasion stage is more affective (feeling) centered[50]. This requires that, after an individual has acquired knowledge on the "what", "how" and "why" of an innovation, the individual's feeling on the use of the new idea also affects his or her adoption and rejection of the innovation. The formation of a favourable or unfavourable attitude towards an innovation, however, does not always lead directly or indirectly to an adoption or rejection of a novelty[50]. Thus, the researcher is of this opinion that a successful use and application of a new way of managing waste in the sanitation/environment agenda may very much relate to the involvement of other actors like pre-service teachers whose environmental knowledge and attitudes are necessary for an effective environmental practices.

3. The Decision Stage

At the decision stage in the innovation-decision process, the individual chooses to adopt or reject the innovation. Adoption on the other hand refers to the full use of an innovation as the best course of action available while rejection means not to adopt an innovation[50]. If an innovation has a partial trial basis where the pre-service teachers do a pretest sorting and trashing trial to verify its effectiveness, it is usually adopted quickly, since most individuals first want to try the innovation in their own situation and come to an adoption decision[50]. However, rejection is possible in every stage of the innovation-decision process. There are two types of rejection: active rejection and passive rejection[50]. In an active rejection situation, an individual tries an innovation and thinks about adopting it, but later he or she decides not to adopt it. In a passive rejection (or non-adoption) position, the individual does not think about adopting the innovation at all. Pre-service teachers can either adopt or

reject the sorting exercise for reduction of waste at source depending on available waste bins and regular lifting of the waste from the school place.

4. The Implementation Stage

At the implementation stage, an innovation is actually put into practice. An innovation, however, brings with it some degree of uncertainty in the diffusion process. Uncertainty about the outcomes of the innovation can still be challenging even at this stage[50]. Thus, the implementer may need assistance from change agents such as Local Authority and private waste collectors like the provision of waste bins and ensuring that there is regular and available means of lifting waste for disposal to reduce the degree of uncertainty about the consequences of their sorting efforts. The innovation-decision process will end when the innovation loses its distinctive quality as the separate identity of the new idea[50]. In other words, a new idea will be implemented better and faster when individuals are able to modify the innovation's use to suit their needs[50]. For example, pre-service teachers will apply proper way of managing waste in their operations when they are able to modify it to suit the way it will enhance clean environment in their daily operations such as sorting and disposal of plastic and other waste in their environs.

5. The Confirmation Stage

At this stage, the innovation-decision has been completed but the individual looks for support for his or her decision[50]. An adopter's decision can be reversed if the individual is exposed to conflicting messages about the innovation like media discussions that create the impression that pre-service teachers are not accountable for waste they generate, but blame authority that do not immediately suffer from its impacts. Individuals, however, tend to stay away from these messages and seek supportive messages that confirm their decision.

Attitudes therefore become more crucial at the confirmation stage; depending on the support for adoption of the innovation and the attitude of the individual, later adoption or discontinuance happens during this stage[50]. The government and civil society will play a critical role at this point by way of providing critical support in the form of resources such as investment in the provision of waste disposal facilities[51] and encouraging the practice of basic sorting. This should ideally be a role played by the public, at the source (of waste generation). Without waste sorting, it practically becomes difficult to manage the waste in a sustainable way. This will make the adopters feel they are making an impact in the waste source reduction and disposal with a view to solving the waste problem. Five attributes were proposed to help decrease uncertainty about an innovation, namely: relative-advantage, compatibility, complexity, trialability, and observability[50]. Further, individuals' perceptions of these characteristics predict the rate of adoption of innovations.

Based on the theory, the diffusion of innovations, new concepts, methods grow over time by spreading in other areas[50]. The time factor in this theory is instrumental as it accounts to the spreading of the different methodologies of waste management concepts across the country and to a greater extend the world. Innovation diffusion theory have formed the basis of various researches in the recent past, integrating innovation into knowledge, attitude, and practice stages of innovation adoption.

Therefore, continuous environmental education in schools is a key concept to this theory because it consists of raising students' knowledge and awareness level on waste management through cultivating student's KAP such as K (knowledge) to perception, A (attitude) to affective, and P (practice) to behaviours actions. Behaviours actions are a result of students learning some skills while P (practice) leads to behaviours change and better

practices[43]. However, other theories have indicated that having environmental knowledge does not necessarily mean having better environmental attitude and practices.

2.2.2 The Health Belief Model (HBM)

Health Belief Model (HBM) is a theory that explains why people do or do not engage in preventive health measures, such as getting tested for a disease, eating healthy food and exercising, or keeping their environment clean. It is one of the models which adopted theories from other disciplines and one of such is the behavioural science to study health problems. It was argued that it is one of the most widely recognised and used models in health behaviour applications[52]. The model explains why people would or would not use available preventive services. The presupposition is that people who feared diseases are influenced by the type of health activities they do. This is seen in the degree of fear (perceived threat) and the expected fear reduction actions so far as that supposed reduction seemed to outweigh practical and psychological barriers to taking action (net benefits). Hence, should the pre-service teachers be equipped with environmental knowledge about activities that can prevent waste related diseases, they will engage in them to prevent diseases, four expectations that exemplify the HBM were explained[52]. These expectations will correspond to the perceived threat of the illness and expected outcome as discussed below:

1. **Perceived Susceptibility**

This refers to how much individuals believe that they are vulnerable to or at risk for some illnesses. In relation to this study, if pre-service teachers believe that the poor way of managing waste generated in the institution poses a risk and that they are at risk to such health hazards then their attitude will change. They will thereby adopt good sanitation

practices based on the knowledge that they are vulnerable. For instance making them aware that plastic waste which does not degenerate easily tends to block culverts, leaving in its wake stagnant water that can cause floods and also serve as a breeding place for mosquitoes, that lead to the high incidence of malaria cases, typhoid, cholera and other contagious diseases will make them to adopt practices aimed at avoiding these negative outcomes.

2. **Perceived Severity**

This refers to how serious the individual believes the consequences of being ill are. The study bears on the presupposition that if the students know that the risk associated with poor sanitation can be fatal, they will change their attitude and engage in practices that improve sanitation in the school. For example, if the students are aware that dirty surroundings breed flies which settle on food items and make them unwholesome and cause a deadly disease like cholera, they will change their attitude.

3. **Perceived Effectiveness**

This refers to the expected benefits if one engages in the protective behaviour[52]. Fitting this into the study, if students realise that by disposing of waste, especially plastic waste in the class will actually reduce the risk of contracting sanitation related diseases they are more likely to engage in proper sanitation practices. To this end, the students will be healthy and go about their daily activities without hindrance.

4. **Perceived Cost**

This refers to the barriers or losses that interfere with health behaviour change[52]. Referring to the barriers and losses that can impede the practice of proper waste management, especially plastic waste, allusion is to the perceived time waste, financial burden and inadequate information on the expected gain associated with improved sanitation practices.

For instance, when students think that practicing proper waste management is relatively time consuming, drawing on their finances or that the practice would not yield any tangible benefits, they are not likely to be motivated to change their attitude and practices despite their awareness of proper waste management.

2.3 Review of Empirical Studies

2.3.1 Environmental Knowledge on Waste Management

1. Level of Education

In a survey study in Turkey, showed that awareness and sensibility levels of campus people about environmental problems including WM, was found to be 64.4%, which may be taken as moderate[53]. Another study in Nigeria examined the level of awareness, knowledge and practices of secondary schools students with regard to waste management in Nigerian educational institutions[54]. Findings revealed that secondary school students from the sampled zones were knowledgeable about waste problems on their school compounds, but still possessed poor waste management practices. Interesting to note, that the environmental knowledge of the students can improve the knowledge of their parents[53]. Further, it was reported that, the majority of students had discussed the programme with their parents, and just over one third of them had made suggestion to their parents regarding the ways in which they could improve their waste management practices at home[53]. On the other hand, the relationship between knowledge of the urban poor households concerning waste management systems and education was analysed which showed that the urban poor communities with low education were proven to behave in ways matching with and conducive to environment-

friendly waste management, for instance, by practicing recycling and waste source reduction than their educated counterparts[45, 48].

A study on household knowledge, attitudes and practices on the separation and recycling of waste indicated that although the public is aware of waste separation and recycling practices, they did not participate in such initiatives[23].

2. Health Education and Sensitisation

For example in a study in Indonesia, respondents‟ awareness of hazardous medical waste rose from 0.6% to 91.4%[36]. Another study on Waste Management in Urban Nyeri, indicated that the majority of the respondents were aware about the health hazards associated with incorrect waste management with the level of awareness being high in all the estates[6]. However, there was a discrepancy between knowledge and correct practice, as only 26.2% of households practiced correct methods of waste disposal (separated, stored into a receptor, deposited into a garbage chamber/compost pit or used kerb side services)[6].

However, awareness and knowledge of waste disposal is influenced by many factors as pointed out in a study on household knowledge, attitudes and practices in waste segregation and recycling in urban Kampala[45]. It indicated that the participation in waste separation activities depended on the level of awareness of recycling activities in the area, household income, educational level and gender[45]. Also, a study on the waste management awareness knowledge and practices of secondary school teachers in Ogun state, Nigeria showed that teachers were aware and knowledgeable about waste management even though they possessed negative waste management practices[54]. Although, there seemed to be appreciable awareness and knowledge about waste disposal among the respondents, most of

them were only aware of the crude and traditional methods and are oblivious of the modern methods such as incineration and recycling[54].

A few other studies showed that the level of consistency between environmental attitudes and behaviours is affected by a person's knowledge and awareness, and his/her sense of responsibility[17, 26, 46]. For instance, in Malaysia, whilst the National Recycling Programme has contributed to a greater awareness of the need to preserve resources, public response, the lack of awareness and knowledge among Malaysian community about waste management (WM) issues, and being ignorant about the effect that improper WM has to the community has definitely worsened the problem.

3. Sources of Information about Waste Management

In a study, the majority of the respondents indicated that they had heard about WM in particular, recycling[48]. The main source of information for 39.3% of the respondents was scrap (metal, plastics, paper, polythene and glass) dealers; followed by relatives and friends, radio, newspapers and magazines estimated at 32.8%, 15.1% and 6.4% respectively. Only 6.4% had heard about recycling from schoo[48]. In a related study on the Economics of Waste Management of Kampala City, it was established that 60% of the respondents had ever heard of the segregation of waste[45]. They even gave examples of what is segregated into plastic bags, glasses, peelings (banana and potatoes) and metal. The report revealed that 39% of the households had heard of waste segregation from friends and relatives, 30% from the itinerant buyers, 27% from newspapers and magazines and 4% from schools[23].

Based on the study targeting students of a selected hostel in Rajasthan University on the variables comprising of waste management knowledge, attitude and practices[8]. The finding indicated low, less favorable, and moderate in knowledge, attitude, and practice

respectively; correlation of knowledge and attitude was absent, practice and knowledge indicated a substantial correlation.

While conducting a research to establish the knowledge and practices on biomedical waste in a population sample of health workers in health care institutions, a cross section study was employed that showed a limited percentage of health care workers, 35.4% had biomedical waste management training and skills, as 31% of them were not vaccinated against hepatitis B diseases[56].

A study on impact of community health awareness and intervention on knowledge, attitude, and behaviours on waste product management and disposal indicated vast knowledge on diseases and health risk associated with waste accumulation for the group that attended the training and education programmes, positive attitude on managing wastes, and improved waste handling practices which include recycling household wastes[56]. The observation showed an increase in community participation in cleaning and other environmental protection activities.

Some researchers believed that environmental problems arise due to the misconceptions of people about environmental concepts[57, 58]. It was pointed out that there are many misconceptions and ignorance about environmental issues and concepts. It was indicated that many misconceptions of both teachers and students about environmental concepts are such as the greenhouse effect and ozone layer depletion. For example, teachers and students considered that one of the outcomes of ozone layer depletion is the greenhouse effect. They also believed that chemical pollutants generated by the exhausts of cars are the only causes of the destruction of the ozone layer. Some information about the greenhouse effect was accepted incorrectly. For example, it was believed that there are no negative

influences of the greenhouse effect on human health. Examples such as those above about misconceptions show that environmental education is not substantial, and not even adequate. The media may also present some concepts about nature incorrectly[58].

It was emphasised that much knowledge about global warming is wrong[59]. Some misconceptions are common among teacher candidates in terms of three issues: ozone depletion, greenhouse effect and acid rain[58]. Similarly, misconceptions on the same three topics were identified[59]. It was suggested that revision must be done in the science teacher education curriculum. It is crucial to treat these kinds of misconceptions in teacher education because pre-service teachers become teachers in schools and they may transmit their misconceptions to pupils. Some participants in a survey said that misconceptions arose from the media because the media sometimes does not express issues adequately[59]. In addition to this, unscientific knowledge given by the media may cause misconceptions.

A study was conducted which showed that pre-service teachers who experienced environmental knowledge would transmit environmental attitudes and awareness to future generations[46]. Therefore, environmental programmes or seminars in pre-service teacher education are important.

A study aimed to find out the effect of three seminars which were 'Let's learn batteries, the causes of battery pollution, and Environmental consciousness about waste batteries'[60]. The seminars were given during chemistry lessons on the topic of environmental consciousness to 265 high school students in İzmir. Pre-tests and post-tests were applied in order to examine the effectiveness of the seminars. At the end of the study, it was found that there was a statistically significant difference between pre-test and post-test results, the post-test scores of the students being higher than their pre-test scores. It was recommended that

these kinds of seminars should be organised for students to increase their awareness of environmental issues[60].

A research also supported the importance of courses about environment and environmental issues in increasing people's awareness towards nature[61]. It was deduced that education about the environment is a good tool to increase people's awareness toward the environment and environmental issues[61]. It was stated that, by generating more consciousness among citizens, environmental education may reduce those problems of the environment that are derived from human impact.

In a study, it was investigated whether there is a relationship between environmental attitudes and behaviour of a group of students in Ankara[57]. The study revealed that 248 secondary school students from four schools in Ankara have low environmental behaviours although their attitudes toward the environment are high. It was advised that compulsory environmental education should be integrated into school curricula in order to increase 'participation in environmental activities'[57].

Also, a research investigated the opinions of 150 pre-service teachers in Ilorin, Nigeria about environmental education[44]. The participants recommended that environmental education should be covered in the social studies curriculum instead of in a separate environmental education course. Also, it should be covered at all levels in schools and it was advocated that relationships between the environment and humans should be covered in social studies.

Also, the importance of environmental education for university students was indicated by saying that, 'Universities for all programmes should provide an education

programme covering environmental science to nurture conscious and sensitive graduate students toward environment'.

2.3.2 Attitude on Waste Management

Attitude refers to the ways you think or feel about something or someone; a feeling or way of thinking that affect person behaviours to their feelings toward recycling, as well as any preconceived ideas they may have towards it. Many community members have poor attitude toward waste management, according to nationwide studies in developing countries. In a study households were asked what they thought about waste separation in their homes. Forty percent said it was a good idea while 60% said they did not support it because it is time wasting and a dirty job, and, therefore, should be done at the collection points or at the landfill[62]. In a study, community members felt it normal to dispose waste anyhow. People throw garbage on the streets and in the drains and gullies because they have no other means of getting rid of (disposing of) their garbage and do not feel irritated by the behaviours[63]. Environmental attitude of young people appears to be crucial as they ultimately play a direct role in providing knowledge-based solutions to in-coming environmental problems[53]. Furthermore, school environmental programme, although addressed to students can also influence upon the environmental knowledge, attitude and behaviours of adults (parents, teachers and local community members) through the process of intergenerational influence[53]. The attitude of people towards waste management can be affected by their level of knowledge and awareness of waste management and it has been reported that homes with waste bins engage more in proper way of storing waste than homes without waste bins[64]. A Ghanaian study about attitude towards recycling of waste management showed no significant

effect of gender, employment and educational statuses, on willingness to practice proper waste management (segregation and recycling)[1].

A number of studies on people's attitudes to the environment have been conducted, for example, it was explored that the environmental attitudes of 1260 secondary school students from twenty-one cities , that the students were aware of environmental problems and willing to come up with solutions to the problems[67].

It was deduced in a survey conducted in İstanbul that people in both developed countries and developing countries such as Turkey had concerns about environmental issues[59]. However, it was stated that although problems about the environment had appeared nearly four decades ago, people began to be concerned about environmental problems only in the 1990s and 2000s[60]. In a survey, environmental attitudes of farmers to the environment was investigated[62]. The farmers' attitude to the environment is important so that they can include protecting the environment while directing agricultural activity.

Studies have been conducted in other countries; For example, researchers investigated the awareness of 300 school teachers in 29 schools in India towards environmental issues using an environmental awareness test developed[8, 21]. The test was composed of 36 multiple-choice questions. The teachers were from different subject areas such as science, social studies, mathematics and languages. The results showed that over half of the participants were aware of environmental problems at a moderate level but fewer had high awareness. In another research study, the environmental attitudes, recycling habits, and relationship between attitudes and recycling habits was determined and it was found that the participants' attitudes were moderate[63]. Some participants who had slightly high attitudes were found to recycle more. In Punjab, India, 2500 science and art teachers were surveyed in order to find

their environmental awareness[69]. The awareness of science teachers towards environmental issues was more than that of art teachers: a large number of science teachers had high environmental awareness, whereas the number of art teachers who had moderate environmental awareness was low.

A study focused on public attitudes towards reducing, reusing and recycling waste in the Makurdi Metropolitan area of Nigeria[70]. It was found that local authority strategy towards a sustainable hierarchy and federal government funding be forthcoming to make necessary infrastructure improvements and embrace public attitudes to waste reduction, reuse and recycling. Some community members prefer engaging in other personal issues like crime, unemployment, and managing the cost of living are more important to community members than a garbage-free community. Majority revealed that they would not waste their time collecting and disposing waste instead of engaging in income generating activities[25, 70]. Some revealed that they would not even waste time engaging in village meeting aimed at garbage management as many said they would rather go boozing. In terms of environmental psychology, researchers found the link between pro-environmental attitudes and recycling behaviour.

A number of theories attempted to explain the recycling activities as pro-environmental behaviours (PEB). The theory of Planned Behaviour assumes that "attitudes have a causal impact on behaviours through the mediation of behavioural intention[61]. This intention is determined by attitudes towards the behaviour, subjective norms, and perceived behavioural control[52]. People might also get motivated to recycle and their behaviours can be regulated by an adequate manipulation of rewards and punishments[52]. Some norm and peer pressure are useful for predicting recycling behaviour. The proposed model basing on the

Theory of Reason Action highlights that the demographic, situational and psychological factors could be also responsible for recycling behaviour[61]. On the contrary, a study found that large number of the respondents had a positive attitude towards waste management as majority of the respondents agreed that proper waste disposal can better their health and majority believed that the practices of waste management is of great importance[56]. Also, majority of respondents specified that waste management promotes good health and healthy environment. Another study showed that respondents in university area of Ogbomoso had a positive attitude towards waste management as 82.0% agreed that waste disposal into drains and around the surroundings is unhealthy and can be disastrous to health[31].

Similarly, in a study aimed at turning waste into resources, community members in rural areas, have a positive attitude towards organic waste[63]. They use it as mulches in their gardens especially banana plantations, cereal gardens coffee plantains. This adds a lot of value to their land through soil fertility from the decayed organic matter.

A study was conducted on waste disposal of waste management and the implication of the results was that the residents of Calabar South had very negative attitude towards waste management and disposal, while there was an influence of indiscriminate disposal of waste and the health status of the residents of Calabar South Local Government Area[62]. The study concluded that because of the negative attitude the residents of Calabar South have towards the management and disposal of their waste, it has some significant influence on their health status.

Also, a study was conducted to establish the effect of attitudes, practices, and knowledge on waste management on 2528 Polytechnic and university student, the findings indicated that 73.4% of the students indicated knowledge to be satisfactory, 71.4% attitude

on strategic waste management issues; while around 43.1% depicted satisfactory levels in practice[66]. The relationship depicted a significant interaction between knowledge and attitude of student prediction. The student rating KAP indicated the link with social status and a significant association with students from families that are medium-sized with parents earning moderate income.

Waste disposal perception and attitude study was conducted in the Tamale Metropolis, Ghana, findings showed there was a strong and significant influence and impact on waste disposal by attitude on households as well as payment for waste collection intentions[1]. A study conducted in Owerri community Imo state residents in Nigeria showed that majority of the respondents were aware of the waste management with majority showing a positive attitude toward managing wastes and protection of the environmental health[29].

2.3.3 Environmental Practice on Waste Management

A study conducted in Owerri community Imo state residents in Nigeria showed that open dumping and burning was practiced which forms the two poor waste management approaches; and Wheel barrow transportation stood out as the most famous means of waste transportation to the dumping site[29].

A review of waste management practices investigated the impact on human health in community waste, and effect of bio aerosol exposure from sewage plant treatment[38]. Results found that community waste had adverse impact outcome on health for the population neighboring dumping sites and nuclear installation. A study also found that, the main waste disposal practices in wastes have a significant influence on environmental hygiene and human health[62].

A study illustrates that, the first R, reduction of solid waste relates to the efficient minimization of solid waste production, waste prevention and diversion from the waste stream; leaving little solid waste for dumping at the landfill site[1]. Presently, high class residential areas in the city patronize the door to door service that is provided by Zoomlion Ghana Limited at a monthly fee of twenty Ghana Cedis (GH¢20) (Equivalent to US$ 6.6)[1]. Per the service contract, the company is required to collect, transport and dispose waste at a dumping site once every week[1]. One of the most striking findings of the study is that, all kinds of solids were dumped in the bins when declared unwanted by the households and institutions; and, there is no separation of solid waste at source. When the dumpster is full of waste, the unsorted load is tipped at the dumping near Siriyiri, a large piece of land fenced for the purpose. The dumping of solid waste into communal containers (mostly placed near public toilet facilities - known as Kumasi Ventilated Improved Pits – KVIPs) remained the common option for domestic solid waste disposal in most low-income households in Wa. These communal containers were provided by both the Municipal Assembly and Zoomlion Ghana Limited. Collection of these communal containers was irregular, which leaves the urban space filled with heaps of uncollected solid wastes especially in the ill-served low income suburbs. The conventional practices of solid waste generation and disposal become twofold environmental issues very critical across the globe and a departure from the tenets of the '3Rs', particularly, waste reduction[71]. Suffice to say that this situation attracts disease-carrying pests and creating grounds for serious public and environmental health hazards[62]. When full, towing vehicle lift the metal bins and empty the content at the dumping site. Presently, there is no strategy in place to reduce the generation of solid wastes at source. There is also no sorting of solid waste either at the central communal collection or dumping

site. Hence, no specific measure is taken by the Municipal Assembly or Zoomlion Ghana Limited-Wa, to directly reduce the volume of solid waste so far as the first R is concerned[1].

The second R, reusing of solid waste involves the principle of 'used ones as substitutes', considering solid waste as 'treasure not trash' and/or 'resource not refuse'[1]. Currently, reusing of solid waste is not quite popular in the municipality. Sachet water plastics are seen collected for sale; intended to be transported from Wa to Kumasi for reuse. Some scavengers were found at the dumping site combing the waste for reuse materials. Such activities are considered illegal by the municipal assembly and are carried out at the blind sight. The reuse of solid waste also resonates in a study that 'to redeem the value of waste, either by reintegrating it with the production system somehow, or by recognizing the use value of certain objects'[1]. Illegally, some farmers collect solid waste from the dumping site and use it in the farm to improve upon soil fertility. The most classic example of reuse is provided by the reuse of plastic bottles, mainly, drinking water and coca cola bottles. Due to the progressively warm weather, people attending meetings and durbars are re-hydrated with water and non-alcoholic drinks. Women and children throng meeting venues and durbar grounds to collect plastic bottles either for re-sale or direct usage for packaging locally made non-alcoholic drink, the very popular drink. The foregoing findings reiterate the argument made by contemporary scholars on waste that developing countries need to rethink waste as a resource (reuse of waste) [1].

The third R, recycling of solid waste into new products is happening on a small scale. The recycling of metal scrap was common among the blacksmith in the Municipality to manufacture simple tools such as hoes, pick axe, coal pots for cooking, "gong", hammers and knives. Electrical welders also depend on scrap metals for the making of metal doors, gates

and beds. Others gather the scrap metals for re-sale for onward transportation to Tema for the manufacture of iron rods in the construction industry. Although, Zoomlion Ghana Limited has the capacity to produce compost – fertilizer from municipal solid waste in Accra and Tamale, the Wa Office lacks such capacity[1]. During the group discussion, indigenous farmers expressed interest in the use of untreated solid waste to boost soil fertility. Hence, compost – fertilizer will be patronized by farmers contingent upon pricing[62].

A study also sought to assess the compliance level of sanitation by-laws in the municipality. It was revealed that the common offences included: accumulation of refuse in the homes, indiscriminate disposal of bath waste water, insanitary drainage systems for bath waste water (behind bathrooms), garbage littered surroundings, over grown weeds, food vending without medical certification, operating a business without refuse bin and obstruction to duty of sanitary inspectors[11, 72]. Offenders are summoned before the law court and usually fined various sums of money depending on the kind of offence committed. Furthermore, study revealed that neither the Wa Municipal Assembly nor Zoomlion Ghana Limited-Wa is currently running any educational or informative programme on sanitation on radio or television[1].

Increase in population in urban centers such as Nairobi has resulted in increased waste management challenges. Lack of funds in the department of urban sanitation and regulations related to sanitation in the city attributes to the increased challenges above. Over 100 million individuals lack access to better sanitation in East Africa[6]. For example, Dandora in East lands, which is a former marram quarry is Nairobi's waste dumping site; human populations living close or neighbouring the dumping sites are at risk of getting diseases and unhygienic environment which are common in developing countries[6].

2.3.4 Environmental Knowledge, Attitude and Practice (KAP) on Waste Management

The use of KAP survey is an emerging popular method to assess community psychology and practices related to environmental issues. A study assessed the attitudes, behaviours, and practices towards the waste management showed that students have a high level of behaviours and practices regarding waste management programme[62]. However, the researchers noted that waste education and awareness strategy are still needed to develop more awareness and attitude towards managing waste to reduce the impact of the waste problem on the campus; but awareness may not easily be translated into practices. For instance, a research explored the level of awareness and practices of waste management of 650 secondary school students from Ogun State in Nigeria, the findings showed that students were aware of the serious problem of waste management in their school, but they had poor waste management practices[55]. It further indicated that their knowledge and practices with regards to waste management significantly differed when the students were categorized according to gender, age, and class membership.

Also, a cross-sectional study was conducted on the knowledge, attitude, and practice of waste disposal and recycling; the findings showed that students had a moderate knowledge of waste disposa[71]. Moreover, their knowledge did not influence them to practice segregation of waste.

Further, a study on the knowledge, attitude, and practices of 358 students in the secondary school towards waste management in Ibadan, Nigeria found that the students had a relatively moderate level of knowledge, attitude, and practice of waste management[74]. However, the evidence of those who used indiscriminate waste disposal methods like open dumping and burning is still higher. The findings also showed that students' gender, age, and

class significantly influenced their level of awareness, knowledge, and practices of waste management. Also, a study conducted to find out the awareness and sensibility levels of 350 campus people about environmental problems[71]. The findings revealed that the respondents showed a moderate level of awareness and sensibility about the environmental problems; but despite their knowledge of the problems, the subjects of the study never showed interest in them.

The KAP survey was done in a research to determine the knowledge, attitude, and practices of college students, specifically on waste management and recycling. In general, the study found out that majority of undergraduate students from LSPU Los Baños Campus, during the 2nd Semester, A.Y. 2015-16, had satisfactory knowledge and attitude[68]; however, less than half had satisfactory practice level on several items on material recycling and participation in environmental programmes. This suggests that most undergraduate students, at the time of the survey were somehow aware of the importance as to proper wastes management and recycling and they also exhibit good attitude towards these matters; however, relatively few students had exemplary practice level.

Another, study also surveyed students from secondary schools, universities, and colleges in Nigeria[70]. The study revealed unsatisfactory knowledge level on environmental issues among student-respondents, but they showed good perception ratings. The students were at least, conscious but they could not "explain on why" environmental problems continue to exist in their community[70]. Similarly, in a studied the KAP regarding waste management in communities near Martaputra River Bank in Indonesia which showed that the community's attitude was deemed highly satisfactory, also their knowledge; however, the participants showed poor actions towards handling and management of river-dumped wastes

by nonparticipation[36]. The gap between knowledge and practices on household wastes was also indicated in the study done in Thrissur City in Kerala, India[8].

Meanwhile, another study explored the village KAP on waste management and the results showed high awareness and favorable attitudes on waste-related issues and topics, among the surveyed members of the communities.; interestingly, the respondents also engaged in favorable practices on waste segregation[63]. The study revealed that the students' knowledge and attitude were positively correlated with their level of practice. The tendency of the students to minimise the use of materials was highly associated with satisfactory knowledge and attitude ratings. Reuse of wastes including plastic/glass bottles, cans, and paper and rainwater was also associated with satisfactory knowledge rating, but not with attitude; whereas, preference to use rechargeable batteries over the disposable types was significantly related to satisfactory attitude ratings.

A great variety of studies about attitudes and knowledge have procured a positive and significant relationship between the above two variables. A research was studied on how levels of knowledge and attitude towards nature conservation could be raised to positively affect visitor education[66]. For all measured concepts, the findings indicate a positive relationship between waste knowledge, attitude, and practices of waste management. High positive correlations between knowledge and practice level were also reported, the respondents with higher knowledge scores were more likely to exhibit good practice on waste management[11].

On the other hand, somewhat contrasting findings were reported in an environmental-KAP survey that involved students from 16 higher learning institutions[47]. It was found that both knowledge and attitude did not necessarily lead to sustainable environmental practices.

The study highlighted that complexity of the relationships between students' KAP towards sustainable environment[47]. Another findings were reported in a knowledge-practice level assessment done in Ogun State, Nigeria, it was revealed that secondary school students from the sampled zones were relatively aware of waste problems in their school compounds, but the same students possessed poor waste management practices[55].

The apparent break in the knowledge-attitude-practices continuum was also demonstrated in another community survey done in Angles City, Pampanga, Philippines. It was shown that high knowledge and favorable attitude toward the environmental issues did not necessarily result in favorable environmentally-sustainable practices[47]. Also, another study did not find relational evidence between attitude and practice, despite their findings on the seeming connection between knowledge and practice levels[47]. Another study reported that KAP level did not vary between male and female respondents[47]. Nonetheless, one study demonstrated that compared to men, women were more aware of the importance of good behaviours towards the environment[48]. This highlights the importance of gender-fair campaigns and other-related programmes relevant to addressing environmental issues and proposed conservation measures. Meanwhile, a weak negative relationship was observed between age and knowledge level[48]. Thus, younger respondents appeared to have better knowledge relative to the elderly as revealed in this study. The same positive correlation results between age and the respondents' knowledge and practice levels were obtained in a study conducted in Oyo State Nigeria[74].

A study also reported that selling or recycling are the usual practice for papers, bottles, plastic containers, and tin cans[48]. It was noted that many households discard waste with other types of wastes[48]. Similarly, indiscriminate waste disposal methods like open dumping and

open burning was reported in Nigeria[31]. It was established in a study that a community-based environmental KAP surveys, are essential to attain significant improvement in waste management systems through recycling schemes or composting, as well on the development and proactive implementation of processes or programmes that could address the declining community awareness on environmental deterioration and the much needed conservation strategies[31]. A study reported that it may be due to the fact that majority of the respondents have tertiary education[10]. Another study showed that knowledge of 65% of students was better than moderate which means knowledge level about refuse management is not adequate because burning of refuse has harmful effect on the environment and it populace; it also causes ozone layer depletion, burying of refuse leads to underground water pollution; and on attitude findings were positive[60]. Study on assessment of the environmental attitudes and practices of teachers undergoing sandwich degree programmes in Nigeria discovered that most of the teachers had positive attitude to environmental issues while the remaining teachers (few) had negative attitude[54].

In a study it was observed that the existing biomedical waste management practices in Kathmandu valley is far from satisfactory and there is an urgent need to critically look into biomedical waste management practices in the valley[75]. A study discovered that most of the teachers (86.1%) disclosed that they engaged in desirable environmental practices while only a few of them (13.9%) displayed undesirable environmental behaviours[46]. It was concluded that there is the need to provide opportunities to acquire the knowledge, values and commitment required to protect and improve the environment.

Further, several studies have been conducted on knowledge, attitude, practices of waste management. A research was designed for assessing Owerri community Imo state

residents in managing wastes in Nigeria, the findings indicated a respondent awareness of waste management and a positive attitude towards waste management[29]. A study indicated that there was low attitude towards waste management by university students, the findings revealed no correlation between waste management and knowledge, attitude, and practices while there was a significant correlation between knowledge and practices in waste management[73].

Perception and attitude on disposal of wastes study in Tamale Metropolis, Ghana, depicted that household attitude have significant impact on the motives to use dustbins in the future[28]. In the review on practices in managing wastes and their effect on human and environmental health, indicates that many of the inhabitants neighbouring the waste dumping sites suffer adverse effects on their health as well as environmental health[28].

Overall, the study illustrates that, the first R, reduction of solid waste relates to the efficient minimization of solid waste production, waste prevention and diversion from the waste stream; leaving little solid waste for dumping at the landfill site[28]. One of the most striking findings of the study was that, all kinds of solids were dumped in the bins when declared unwanted by the households and institutions; and, there is no separation of solid waste at source. The dumping of solid waste into communal containers (mostly placed near public toilet facilities - known as Kumasi Ventilated Improved Pits – KVIPs) remained the common option for domestic solid waste disposal in most low-income households in Wa[28]. These communal containers are provided by both the Municipal Assembly and Zoomlion Ghana Limited. Collection of these communal containers is irregular, which leaves the urban space filled with heaps of uncollected solid wastes especially in the ill-served low income suburbs. The conventional practices of solid waste generation and disposal become twofold

environmental issues very critical across the globe and a departure from the tenets of the '3Rs', particularly, waste reduction[28]. Suffice to say that this situation attracts disease-carrying pests and creating grounds for serious public and environmental health hazards[1]. When full, towing vehicle lift the metal bins and empty the content at the dumping site. Presently, there is no strategy in place to reduce the generation of solid wastes at source. There is also no sorting of solid waste either at the central communal collection or dumping site. Hence, no specific measure is taken by the Municipal Assembly or Zoomlion Ghana Limited-Wa, to directly reduce the volume of solid waste[28].

The second R, reusing of solid waste involves the principle of 'used ones as substitutes', considering solid waste as 'treasure not trash' and/or 'resource not refuse'. Currently, reusing of solid waste is not quite popular in the municipality. Sachet water plastics are seen collected for sale; intended to be transported from Wa to Kumasi for reuse[28]. Some scavengers were found at the dumping site combing the waste for reuse materials. Such activities are considered illegal by the municipal assembly and are carried out at the blind sight. A study on the reuse of solid waste shows that to redeem the value of waste, either by reintegrating it with the production system somehow, or by recognizing the use value of certain objects[5]. Illegally, some farmers collect solid waste from the dumping site and use it in the farm to improve upon soil fertility. The most classic example of reuse is provided by the reuse of plastic bottles, mainly, drinking water and coca cola bottles. Due to the progressively warm weather, people attending meetings and durbars are re-hydrated with water and non-alcoholic drinks. Women and children throng meeting venues and durbar grounds to collect plastic bottles either for re-sale or direct usage for packaging locally made non-alcoholic drink, the very popular "sobolo" drink. The argument made by contemporary

scholars on waste that developing countries need to rethink waste as a resource (reuse of waste) [1, 28].

The third R, recycling of solid waste into new products is happening on a small scale. The recycling of metal scrap was common among the blacksmith in the Municipality to manufacture simple tools such as hoes, pick axe, coal pots for cooking, "gong", hammers and knives[45]. Electrical welders also depend on scrap metals for the making of metal doors, gates and beds. Others gather the scrap metals for re-sale for onward transportation to Tema for the manufacture of iron rods in the construction industry. Although, Zoomlion Ghana Limited has the capacity to produce compost fertilizer from municipal solid waste in Accra and Tamale, the Wa Office lacks such capacity[28].

2.4 Conceptual Model

The independent variables were environmental knowledge, attitude and practices while the dependent variable was solid waste management (reduce, reuse, recycling and waste disposal). Environmental knowledge was measured by assessing the respondents' knowledge through awareness programmes, environmental topics and health problems; especially on the influence of it on solid waste management. Attitude was measured by assessing the attitude of pre-service teachers towards solid waste management (reduce, reuse, recycling and waste disposal) in the college. Environmental practices were assessed by solid waste reduce, reuse, recycling and waste disposal method. The dependent Variables (environmental knowledge, attitude and practices if they are good and positive will lead to positive outcomes but if otherwise it will lead to the current solid waste management method of dropping waste indiscriminately within the classrooms and school environs. The dropping

of waste anyhow and anywhere (consequences of indiscriminate dumping of refuse/waste may lead to health hazards, accidents, drainage blockage, among others). However, the innovation-decision process from Diffusion of Innovation theory may lead to positive outcome (sound health, neat environment, clean classrooms from early morning till closing hour), whereby, the pre-service teachers will have adequate level of environmental knowledge, positive environmental attitude and good environment practices will later be diffused to their students in the future. The innovation-decision process from diffusion of innovation theory are explained below in relation to this study.

The innovation-decision process in Diffusion of Innovation theory were the five ordered steps in relation to improving solid waste management. At the Knowledge Stage an individual learns about the existence of innovation and seeks information about the innovation. Awareness-knowledge can motivate the pre-service teachers to learn more about the innovation and eventually, to adopt it. When pre-service teachers are aware of the relatedness of environmental knowledge, attitudes and practices within the environment and how it affects either negatively or positively their operations, livelihoods and health, it becomes imperative for them to concern themselves with the innovation. Pre-service teachers need to know how to effectively manage solid waste through acquiring the relevant knowledge which will help shape their attitudes and this will lead them put it into practice measures that deal with the problem of solid waste management. The persuasion stage occurs when the individual has a negative or positive attitude toward the innovation. Although, pre-service teachers may be equipped with knowledge and skills in handling materials and other waste, the success of implementing the new idea (sorting waste into different categories, reducing waste at the source, reusing, recycling and disposing waste appropriately) with

sanitation education depends greatly upon the attitudes of the pre-service teachers and their willingness to embrace such innovation. An individual's knowledge about an innovation shapes his or her attitude towards the innovation.

At the third stage which is the decision stage in the innovation-decision process, the individual chooses to adopt or reject the innovation. If an innovation has a partial trial basis where the pre-service teachers do a pretest sorting and trashing trial to verify its effectiveness, it is usually adopted quickly, since most individuals first want to try the innovation in their own situation and come to an adoption decision. However, rejection is possible in every stage of the innovation-decision process. Pre-service teachers may either adopt or reject the sorting exercise for reduction of waste at source depending on available waste bins and regular lifting of the waste from the school place.

At the implementation stage, an innovation is actually put into practice. An innovation, however, brings with it some degree of uncertainty in the diffusion process. Uncertainty about the outcomes of the innovation can still be challenging even at this stage. Thus, the implementer may need assistance from change agents such as Local Authority and school waste collectors like the provision of waste bins and ensuring that there is regular and available means of lifting waste for disposal to reduce the degree of uncertainty about the consequences of their sorting efforts. In other words, a new idea will be implemented better and faster when individuals are able to modify the innovation's use to suit their needs For example, pre-service teachers will apply proper way of managing solid waste in their operations when they are able to modify it to suit the way it will enhance clean environment in their daily operations such as reducing, reusing, recycling and waste sorting and disposal of plastic and other waste in their environs.

At the last stage the innovation-decision has been completed but the individual looks for support for his or her decision. An adopter's (pre-service teachers) decision can be reversed if the individual is exposed to conflicting messages about the innovation like media discussions that create the impression that pre-service teachers are not accountable for waste they generate, but blame authority that do not immediately suffer from its impacts. Individuals, however, tend to stay away from these messages and seek supportive messages that confirm their decision. Attitudes therefore become more crucial at the confirmation stage; depending on the support for adoption of the innovation and the attitude of the individual, later adoption or discontinuance may happen during this stage. Therefore, continuous environmental education in schools is a key concept because it consists of raising students' knowledge and awareness level of solid waste management through cultivating student's KAP such as K (knowledge) to perception, A (attitude) to affective, and P (practice) to behaviours actions.

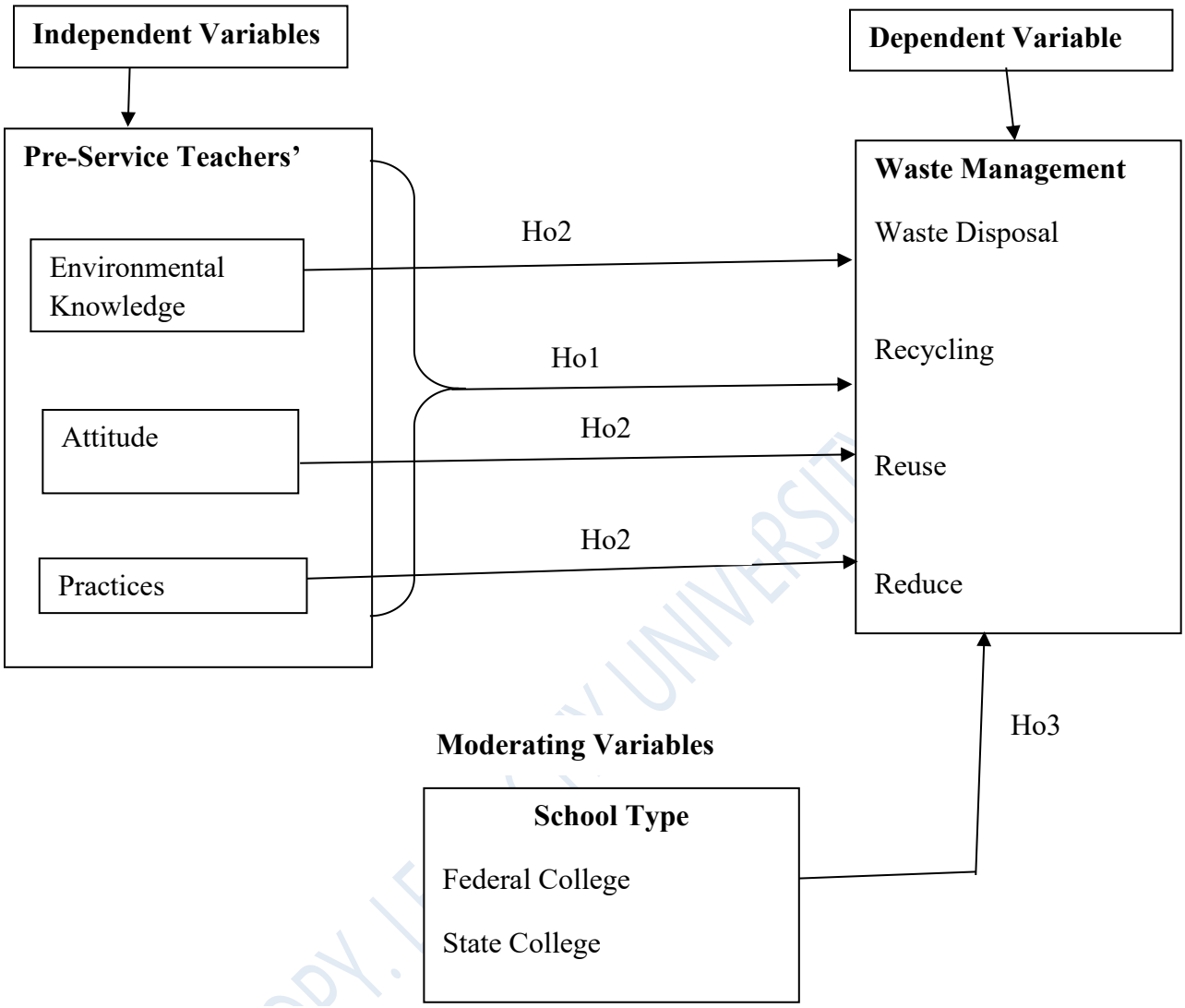

Figure 2.4: Conceptual Model of Pre-Service Teachers' Environmental Knowledge, Attitude, Practices of waste management

Source: Researcher, 2022

2.5 Summary of Literature Reviewed

The literature reviewed has particularly displayed the background information about research on environmental knowledge, attitude, practices and solid waste management. Environmental knowledge is important not only for students but also for pre-service and in-

service teachers because teachers are the basis of education in the schools. Therefore, the importance of environmental knowledge was emphasised in the literature review section.

Waste were seen as unwanted materials, substances or objects which are disposed or intended to be disposed-off by the provision of the law at state or national levels. It can further be seen as substances or objects discarded as useless or unwanted from human and animal activities. Solid waste management therefore, involved the reduction, reusing, recycling, collection, transport, treatment and disposal of waste including after care of disposal sites. Waste management is the generation, prevention, characterisation, monitoring, treatment, handling, reuse and residual disposition of materials produced by human activities in order to reduce their effect on health and the environment.

The waste management hierarchy classifies waste management strategies according to their order of importance and is the cornerstone of most waste minimisation strategies. Traditionally, the communities have been in charge of providing waste management services in developing countries. Responsibility is to organise and manage the public sanitation system, including providing the infrastructure for the collection, transportation, treatment and disposal of wastes. However, with ever increasing population and economic growth, many communities in developing countries are struggling to keep waste management working in a sustainable manner.

Further, teachers are the most important factor in achieving environmental education objectives; they are crucial in developing positive attitudes toward the environment, environmental knowledge and solid waste management in students. A teacher who has environmental knowledge and positive attitude will have a good solid waste practice and teach students appropriately about the environmental knowledge, attitude and practices on

solid waste management (reduce, reuse, recycling and good method of waste disposal). Environmental Knowledge about solid waste management is highly influenced by participating in the environmental health education sessions. Increases in knowledge about types of diseases spread and types of hazardous waste are particularly pronounced among health educated population compared to groups without health education. Attitude influences behaviour of people in taking decision on issues especially issues that concerns the environment; the knowledge, attitudes and practices of a community and found that changes in attitudes and waste disposal practices tell what people know about certain things, how they feel and also how they behave. Practice refers to the ways or methods of waste disposal that are demonstrated by the pre-service teachers.

The literature reviewed has demonstrated the complicated interactions that exist within the solid waste management processes by providing an overview of relevant research that has been carried out primarily of solid waste management operations (reduce, reuse, recycling, waste disposal, collection, storage, transportation, transfer, and treatment), sustainable waste management, waste management environmental performance, of waste management decision-making. This has provided a general understanding of waste management systems, particularly systems in developing countries and the challenges militating against the effective functioning of these systems, especially improper disposal of waste which causes various pollution (air, soil, water and landscape) and affects the health of inhabitants and the beauty of cities. Therefore, this research investigated Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management

Further, several theoretical frameworks were pertinent to pre-service teachers' environmental knowledge, attitudes and practices in the adoption of basic environmental

sanitation behaviours. However, this study adapted Diffusion of Innovation (DOI) theory and Health Belief Model (HBM). The rationale for adapting Diffusion of Innovation (DOI) theory is to illustrate how any new innovation moves from creation to widespread use or non-use. Innovation is an idea, practice or object that is perceived as novel by the individual, and diffusion is the process by which an innovation makes its way through a social system. Health Belief Model (HBM) explains why people do or do not engage in preventive health measures, such as getting tested for a disease, eating healthy food and exercising, or keeping their environment clean.

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Chapter Three

Methodology

3.1 Research Design

This study adopted the descriptive survey research design of the *ex-post facto* type. This design was adopted because it helped the researcher to make a proper investigation for description, drawing inferences and making generalisation; while determining how the

independent variables influenced the dependent variable. This design was also adopted because the researcher did not manipulate the variables of the study since the variables had already occurred.

3.2 Population of the Study

The population of the study comprised all the pre-service teachers in Colleges of Education in Oyo Township.

Table 3.1: Population of Pre-Service Teachers in Colleges of Education, Oyo Town

S/N	College	Name of School	Population		
			100L	200L	300L
1.	Alayande College of Education	School of Secondary Education (Arts and Social Sciences)	324	269	108
		School of Secondary Education (Sciences Programmes)	383	314	175
		School of Secondary Education (Language	230	225	105

		Programmes)			
		School of Secondary Education (Vocational and Technical Programmes)	334	275	179
		School of Early Childhood Care and Primary Education (ECCPE)	76	70	45
		School of Education	29	64	40
2.	Federal College of Education (SP) Oyo	School of Secondary Education (Arts and Social Sciences Programmes)	830	870	781
		School of Secondary Education (Sciences Programmes)	554	610	511
		School of Secondary Education (Vocational and Technical Programmes)	475	446	413
		School of Secondary Education (Language Programmes)	314	275	216
		School of Early Childhood Care and Primary Education (ECCPE)	87	126	103
Total			**3636**	**3545**	**2676**

Source: Admission Office of the Colleges (2022)

3.3 Sample and Sampling Technique

The sample size for this study was eight hundred and fifty four (854) (see the table below). The purposive sampling technique was used in selecting Oyo Township because it is an ancient city. Also, purposive sampling technique was used to select pre-service teachers from the existing colleges of education in Oyo Township, namely: Emmanuel Alayande College of Education, Oyo and Federal College of Education (SP) Oyo. Further, this study used purposive sampling techniques to select two schools from each of the colleges in Oyo Township. The selected schools were School of Secondary Education (Arts and Social Sciences); and School of Secondary Education (Sciences Programmes).

In addition, the above schools were selected from each school respectively, based on the fact that the selected schools had high population of students compare to other schools in the colleges; also, Arts and social sciences include Social studies Education as core courses in the school which teaches about the environment and sciences has subject areas that teaches about environment and management of waste.

The sample size of the study population was calculated using the following formula[1]:

$$n = \frac{N}{1 + N(e)^2}$$

Where e = 0.05,

N = Population

n = Sample Size

Table 3.2: Total Sample Size for the Study

S/N	College	Name of School	Population	Sample Size
1.	Alayande College of Education	School of Secondary Education (Arts and Social Sciences)	269	161
		School of Secondary Education (Sciences Programmes)	314	175
2.	Federal College of Education (SP) Oyo	School of Secondary Education (Arts and Social Sciences	870	274

	Programmes)		
	School of Secondary Education (Sciences Programmes)	610	244
Total		**2063**	**854**

Source: Admission Office of the Colleges (2022)

3.4 Instrument for Data Collection

The main instruments for data collection from the pre-service teachers in this study was "Environmental Knowledge, Attitude and Practices of solid waste management Questionnaire (EKAPSWMQ)". The Environmental Knowledge, Attitude and Practices of Solid Waste Management Questionnaire (EKAPSWMQ) consisted of seven sub-sections with question items on all variables. This questionnaire was self-developed by the researcher to collect information on environmental knowledge, attitude and practices (KAP) influencing solid waste management. It was constructed with the use of the four point Liker-t rating scale with responses varying from Mostly = 4, Sometimes = 3, Rarely = 2 and Never = 1; and Strongly agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2 and Strongly disagree (SD) = 1

3.5 Validity of the Instrument

The validity of the instrument was ascertained through face and content validity. To ascertain the face and content validity of the instrument, the instrument was given to experts in Social studies and the researcher's supervisor. The corrections, criticisms and opinions was studied carefully and incorporated into the final draft copy was trial-tested it to pilot study.

3.6 Reliability of the Instrument

The reliability of the instrument was determined through test and re-test method within two weeks. The instrument was tested among 50 respondents in Oyo State College of

Education, Lanlate that was not part of the study area. The result of the test and re-test was computed using Pearson product moment correlation coefficient. The value of 0.83 was obtained indicating high accuracy of the instrument.

3.7 Administration of Instrument and Method of Data Collection

The researcher obtained due authorization letter of introduction from the Department before conducting the fieldwork. Thereafter, four (two in each selected college) research assistants were recruited and trained on the questionnaires' administration. Thereafter, courtesy visit was paid to the school in order to notify them about the aim of the study and the need for the cooperation of students with the research staff within a period of one month to administer the instruments to the respondents. The researcher with the assistance of the four research assistants explained all aspects of the instruments to the respondents. The respondents were assured of the confidentiality of the information supplied. All administered questionnaire were collated within the time frame for data analysis. The total number of questionnaires that were distributed to the respondents were eight hundred and fifty four (854), 844 were retrieved from the respondents, and 832 were properly filled, valid and used for the analysis.

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3.8 Method of Data Analysis

Data collected in this study were analysed using descriptive statistics such as frequency counts, simple percentages, mean, standard deviation and rank was used to analyse Research questions 1 to 5 and multiple regression was used for the analysis of hypotheses 1 and 2, while t-test was used to analysed hypothesis 3. All hypotheses were tested at 0.05 level of significance.

Endnote

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Chapter Four

Results and Discussion of Findings

This chapter presented results and discussion of findings. It contains the following subsections: presentation of demographic information of the respondents, answers to research questions, test of hypotheses and discussion of findings.

4.1 Presentation of Demographic Characteristics of Respondents

Table 4.1: Distribution of Respondents by Gender

S/N	Gender	Frequency	Percentage
1	Male	342	41.1
2	Female	490	58.9
Total		**832**	**100**

Source: Fieldwork, 2022

Table 4.1 presented the gender distribution of respondents that took part in this study. It showed that female were 58.9% which means they were more represented than male which were 41.1%. This difference does not in any way affect the result of the study since gender was not considered as a variable in the study.

Table 4.2: Distribution of the Respondents by Age Range

S/N	Age Range	Frequency	Percentage
1	16 years and below	85	10.2
2	17-21	415	49.9
3	22-26	159	19.1

4	27 and Above	173	20.8
Total		**832**	**100**

Source: Fieldwork, 2022

Age distributions of respondents were presented in table 4.2 above. The table showed that the respondents between age range of 16 years and below were 10.2%; age range of 17-21 years were the highest represented with 49.9% of the total sample of the study; this was followed by those that were between the age range of 27 years and above which were 20.8% and those between age range of 22-26 years were 19.1% which were the least represented in this study. Again, it should be pointed out that this observed age distribution does not in any way influence the findings of the study as age was not considered as a variable in this study. Although, it may be a factor to waste management in Oyo Township.

4.2 Analysis of Respondents' Opinion on Research Questions

Prevalent Type of Solid Waste Produced by Pre-service Teachers

To determine the most prevalent type of solid waste produced by the pre-service teachers and has stated by the objective one and **Research Question One:** What is the most

prevalent type of solid waste produced by pre-service teachers in Oyo Township? Descriptive statistics of frequency count, percentage, standard deviation and rank was used for the analysis and the result is presented in table 4.3.

Table 4.3: Distribution of the Respondents by the Most Prevalent Type of Solid Waste Produced by Pre-service Teachers in Oyo Township

S/N	Question Items	Mostly	Sometimes	Rarely	Never	Mean	Std
	Organic waste (Biodegradable waste)						
1.	Food left over	662(79.6%)	170(20.4%)	00	00	3.80	0.403
2.	Used Papers and folders	372(44.7%)	379(45.6%)	00	00	3.35	0.650
3.	Pens	458(55.0%)	332(39.9%)	42(5.0%)	00	3.50	0.593
4.	Pieces of clothes	361(43.4%)	130(15.6%)	299(35.9%)	42(5.0%)	2.97	0.998
5.	Fruit and vegetable peels	167(20.1%)	375(45.1%)	252(30.3%)	38(4.6%)	2.81	0.806
	Weighted Mean					**3.29**	**0.69**
	Inorganic Waste (Non-biodegradable wastes)						
6.	Plastics of different types	537(64.5%)	170(20.4%)	87(10.5%)	38(4.6%)	3.45	0.855
7.	Empty bottles used for drinks	154(18.5%)	385(46.3%)	293(35.6%)	00	2.83	0.714
8.	Glasses, Tin and Metals	288(34.6%)	329(39.5%)	127(15.3%)	88(10.6%)	2.98	0.961
9.	Batteries	167(20.1%)	285(34.3%)	293(35.2%)	87(10.5%)	2.64	0.918
10.	Plates	168(20.2%)	293(35.2%)	241(29.0%)	130(15.8%)	2.60	0.979

11.	Spoons	298(35.8%)	241(29.0%)	167(20.1%)	126(15.1%)	2.85	1.070
12.	Bags	202(24.3%)	378(45.4%)	170(20.4%)	82(9.9%)	2.84	0.904
13.	Book cases	366(44.0%)	261(31.4%)	167(20.1%)	38(4.6%)	3.15	0.896
14.	Nylons	335(40.3%)	162(19.5%)	249(29.9%)	86(10.3%)	2.90	1.052
	Weighted Mean					**2.92**	**1.027**

Threshold: Mean: < 2.5 High; 2.5-2.99 Moderate; > 2.99 High

Source: Fieldwork, 2022

Table 4.3 showed the most prevalent type of solid waste produced by pre-service teachers in Oyo Township. In determining this, solid waste was divided into two which were organic and in-organic. The result showed that organic solid waste with weighted mean value of 3.29 which were more produced in the study location than the in-organic waste with weighted mean value of 2.92.

Level of Pre-service Teachers' Environmental Knowledge of Solid Waste Management

To determine the level of pre-service teachers' environmental knowledge of solid waste management in Oyo Township as stated by objective two and **Research Question Two:** What is the level of pre-service teachers' environmental knowledge of solid waste management (reduce, reuse, recycling and waste disposal)? Descriptive statistics of frequency count, percentage, standard deviation and rank was used for the analysis and the result is presented in table 4.4 below.

Table 4.4: Distribution of Respondents by Level of Pre-service Teachers' Environmental Knowledge of Solid Waste Management

S/N	Question Items	VH	H	L	VL	Mean	Std

1.	Waste disposal in the drainage system causing environmental hazard	628(75.5%)	44(5.3%)	86(10.3%)	74(8.9%)	3.47	0.995
2.	Principles of waste minimisation by segregation	445(53.5%)	219(26.3%)	44(5.3%)	124(14.9%)	3.18	1.073
3.	The complications of improper waste disposal	291(35.0%)	247(29.7%)	250(30.0%)	44(5.3%)	2.94	0.927
4.	The importance of using protective clothing (gloves, appropriate cloths, masks, etc) for handling waste	334(40.1%)	213(25.6%)	247(29.7%)	38(4.6%)	3.01	0.939
5.	The use of rechargeable batteries	249(29.9%)	336(40.1%)	165(19.8%)	82(9.9%)	2.90	0.940
6.	Repairing items instead of throwing them away	174(20.9%)	335(40.3%)	198(23.8%)	125(15.0%)	2.67	0.970
7.	Reusing to reduce waste handling and disposal cost	131(15.7%)	249(29.9%)	250(30.0%)	202(24.3%)	2.37	1.017
8.	Reusing items to save landfill spaces	337(40.5%)	204(24.5%)	174(20.9%)	117(14.1%)	2.91	1.082
9.	Waste recycling in my community to save landfill spaces	204(24.5%)	412(49.5%)	83(10.0%)	133(16.0%)	2.83	0.977
10.	Recycling waste items to help save the environment	385(46.3%)	81(9.7%)	280(33.7%)	86(10.3%)	2.92	1.099

	from hazards						
11.	Recycling reduces the community dependence on landfill	126(15.1%)	360(43%)	261(31.4%)	85(10.2%)	2.63	0.860
12.	Recycling containers near my house/school to save the environment	220(26.4%)	245(29.4%)	198(23.8%)	169(20.3%)	2.62	1.083
13.	Avoiding single-use food and drink containers and utensils	209(25.1%)	379(45.6%)	81(9.7%)	163(19.6%)	2.76	1.038
14.	Buy in bulk to reduce packaging dirtying the environment	431(51.8%)	228(27.4%)	173(20.8%)	00	3.31	0.794
15.	Compositing solid waste	245(29.4%)	376(45.2%)	211(25.4%)	00	3.04	0.740
16.	Curbing my use of paper through mail, receipts magazines and so on.	263(31.6%)	199(23.9%)	241(29.0%)	129(15.5%)	2.72	1.071
	Weighted Mean					**2.89**	**0.918**

Threshold: Mean: < 2.5 Low; 2.5-2.99 Moderate; > 2.99 High

Source: Fieldwork, 2022

Table 4.4 presented the level of pre-service teachers' environmental knowledge of solid waste management (reduce, reuse, recycling and waste disposal). Judging from the weighted mean, it can be deduced that the level of pre-service teachers' environmental knowledge in Oyo Township is moderate (2.89)

Attitude of Pre-service Teachers to Solid Waste Management

To determine the attitude of Pre-service teachers to solid waste management as stated by the objective three and **Research Question Three:** What is the attitude of Pre-service teachers to solid waste management (reduce, reuse and recycle)? Descriptive statistics of frequency count, percentage, standard deviation and rank was used for the analysis and the result is presented in table 4.5 below.

Table 4.5: Attitude of Pre-service Teachers to Solid Waste Management (Reduce, Reuse and Recycle) in Oyo Township

S/N	Question Items	SA	A	D	SD	Mean	Std
1.	Dumping waste in the gutter makes me feel bad because it shows poor waste management	491(59.0%)	87(10.5%)	165(19.8%)	89(10.7%)	3.18	1.089
2.	Those who make the environment dirty should be punished	216(26.0%)	285(34.3%)	212(25.5%)	119(14.3%)	2.72	1.004
3.	If people continue to dump waste indiscriminately, we will soon experience a major environmental catastrophe	401 (48.2%)	348 (41.8%)	45 (5.4%)	38 (4.6%)	3.34	0.774
4.	Everybody, including students should learn how to protect the environment	378(45.4%)	160(19.2%)	45(5.4%)	249(29.9%)	2.80	1.292
5.	I avoid single-use food and drink containers and utensils to reduce	44(5.3%)	534(64.2%)	254(30.5%)	00	2.75	0.543

	landfill waste disposal						
6.	I must ensure that I and others disposed wastes properly	549(66.0%)	154(18.5%)	85(10.2%)	44(5.3%)	3.45	0.878
7.	Recycling of waste items should be encouraged	85(201%)	246(29.6%)	375(45.1%)	126(15.1%)	2.35	0.857
8.	Indiscriminate littering of wastes and urination around the school premises contributes to environmental hazards	210(25.2%)	412(49.5%)	168(20.2%)	42(5.0%)	2.95	0.808
9.	I must take action voluntarily to keep my environment clean by using dust bin as appropriate	248(29.8%)	279(33.5%)	130(15.6%)	175(21.0%)	2.72	1.104
10.	Composting of food waste should be encouraged to reduce landfill	464(55.8%)	237(28.5%)	131(15.7%)	00	3.40	0.745
11.	I am worried about how waste are handled around my school premises	340(40.9%)	363(43.6%)	84(10.1%)	45(5.4%)	3.20	0.829
12.	Students should cultivate the habit of reducing waste they produced through reuse	325(39.1%)	374(45.0%)	88(10.6%)	45(5.4%)	3.18	0.826
13.	It displeases me on how my fellow	211(25.4%)	243(29.2%)	333(40.0%)	45(5.4%)	2.75	0.898

	students regard and handle waste in the classroom and school premises						
14.	I am satisfied with the way my school management handles waste	83(10.0%)	429(51.6%)	161(19.4%)	159(19.1%)	2.52	0.912
15.	I often remind other students to separate and drop waste appropriately in the waste bin	461(55.4%)	123(14.8%)	174(209%)	74(8.9%)	3.17	1.045
16.	I often share information on waste management with other students	201(24.2%)	301(36.2%)	174(174%)	74(8.9%)	2.66	1.041
17.	I believe that improper waste disposal is a threat to Environment	286(34.4%)	217(26.1%)	131(15.7%)	198(23.8%)	2.17	1.171
18.	Waste management (waste disposal, reuse, reduce and recycle) is my responsibility and not only that of the school management	347(41.7%)	240(28.8%)	156(18.8%)	89(10.7%)	3.02	1.017
19.	I am responsible for reminding other students on proper waste disposal (pick and dispose waste)	248(29.8%)	214(25.7%)	370(44.5%)	89(10.7%)	2.85	0.850

20.	It is important to read and share information on waste management (waste disposal, reuse, reduce and recycle) with other Students	128(15.4%)	214(25.7%)	249(29.9%)	241(29.0)	2.28	1.043
	Weighted Mean					**2.87**	**0.989**

Threshold: Mean: < 2.5 Negative; 2.5-2.99 Indifferent; > 2.99 Positive

Source: Fieldwork, 2022

Table 4.5 presented the results on the attitude of pre-service teachers to solid waste management (reduce, reuse, recycling and waste disposal) in Oyo Township. Judging from the weighed mean, it can be concluded that pre-service teachers in Oyo Township were indifferent (2.87) in terms of attitude towards waste management (reduce, reuse, recycling and waste disposal).

Dominating Solid Waste Disposal Practices

To determine the dominating solid waste disposal practices among the pre-service teachers in Oyo Township as stated by objective four and **Research Question Four:** What are the dominating solid waste disposal practices among pre-service teachers in Oyo Township? Descriptive statistics of frequency count, percentage, standard deviation and rank was used for the analysis and the result is presented in table 4.6 below.

Table 4.6: Distribution of Respondents by the Dominating Solid Waste Disposal Practices among Pre-service Teachers in Oyo Township

S/N	Question Items	Mostly	Sometimes	Rarely	Never	Mean	Rank
	Practices of Solid Waste Disposal						

1.	Composting waste	465(55.9%)	323(38.8%)	44(5.3%)	00	3.51	6th
2.	Open burning of dry waste	334(40.1%)	416(50.0%)	82(9.9%)	00	3.30	2nd
3.	Incineration	381(45.8%)	246(29.6%)	167(20.1%)	38(4.6%)	3.17	3rd
4.	Dust bins	213(25.6%)	361(43.4%)	172(20.7%)	86(10.3%)	2.84	1st
5.	Dump pits	242(29.1%)	373(44.8%)	173(20.8%)	44(5.3%)	2.98	4th
6.	Landfill Site	214(25.7%)	324(38.9%)	252(30.3%)	42(5.0%)	2.85	5th

Source: Fieldwork, 2022

Dominating solid waste disposal practices among pre-service teachers was presented in table 4.6 above, the result showed that dust bin is the most dominating solid waste disposal practice among pre-service teachers in Oyo Township. This was followed by open burning of dry waste, incineration, dump pits, and landfill site respectively; while composting waste is the least waste disposal practice among pre-service teachers in Oyo town.

Dominating Solid Waste Management

To determine the dominating solid waste management among pre-service teachers in Oyo township as stated in objective four and **Research Question Five:** What is the dominating solid waste management (waste disposal, reduce, reuse and recycle) among pre-service teachers in Oyo township? Descriptive statistics of frequency count, percentage, standard deviation and rank was used for the analysis and the result is presented in table 4.7 below.

Table 4.7: Dominating Solid Waste Management (reduce, reuse and recycling) among Pre-service Teachers in Oyo Township

S/N	Question Items	Mostly	Sometimes	Rarely	Never	Mean	Rank

	Practices of Solid Waste Management						
1.	Recycling	242(29.1%)	215(25.8%)	205(24.6%)	170 (20.4%)	2.64	3rd
2.	Reuse	170(20.4%)	344(41.3%)	274(32.9%)	44(5.3%)	2.77	2nd
3.	Reduce	301(36.2%)	284(34.1%)	203(24.4%)	44(5.3%)	3.01	1st

Source: Fieldwork, 2022

Table 4.7 presented the dominating solid waste management (reduce, reuse and recycling) among pre-service teachers in Oyo Township. It showed that reducing waste is the most dominating solid waste management among pre-service teachers in Oyo Township. This was followed by reuse and recycling respectively.

4.3 Presentation of Test of Hypotheses

Combined Influence of Pre-service Teachers' Environmental Knowledge, Attitude, and Practices of solid waste management

To determine the combined influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township as stated in objective five and **$H_0$1:** There will be no significant combined influence of pre-service teachers' environmental knowledge, attitude, and practices of solid waste management in Oyo Township. Multiple Regression was used for the analysis and the result is presented in table 4.8 below.

Table 4.8: Summary of Regression Analysis of Combined Influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township

Model Summary

Model	**R**	**R Square**	**Adjusted R**	**Std. Error of**	**Change Statistics**

			Square	the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
	.565	.319	.316	1.51078	.319	129.160	3	828	.000

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	884.404	3	294.801	129.160	.000
	Residual	1889.874	828	2.282		
	Total	2774.278	831			

a**. Dependent Variable**: Solid Waste Management

b**. Predictors:** (Constant), Practices, Pre-service Teacher Environmental Knowledge, Pre-service Teachers' Attitude

Source: Fieldwork, 2022

Table 4.8 showed the summary of regression analysis on the influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township, result showed a ($p < 0.00$) meaning there was significant combined influence, therefore, the null hypothesis was rejected at 0.05 level of significance. The result also gave (Adj. $R^2 = 0.316$) meaning that 32 percentage of the variation is accounted for when the independent variables pre-service teachers' environmental knowledge, attitude and practices were considered jointly.

Relative Influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management

To determine the relative influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township as stated in objective six and **$H_0$2**: There will be no significant relative influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township. Multiple Regression was used for the analysis and the result is presented in table 4.9 below.

Table 4.9: Summary of Regression Analysis of Relative Influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	.177	.733		.242	.809
	Pre-service Teacher Environmental Knowledge	.086	.014	.202	6.237	.000
	Attitude	.044	.012	.144	3.603	.000
	Practices	.370	.032	.497	11.461	.000

a. **Dependent Variable:** Solid Waste Management

Source: Fieldwork, 2022

Table 4.9 presented the summary of regression analysis of relative influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township. Result showed that waste management practices contributed the most to solid waste management among pre-service teachers in Oyo town ($\beta = .497$, $p < 0.05$). This was followed by environmental knowledge ($\beta = .202$, $p < 0.05$) and attitude of pre-service teacher ($\beta = .144$, $p < 0.05$) respectively. Hence, the null hypothesis was rejected at 0.05 level of significance.

College Type Difference in Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management

To determine the college type difference in Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township as stated in objective seven and **$H_0$3:** There will be no significant college type difference in Pre-

Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township. T-test was used for the analysis and the results are presented in table 4.10 to table 4.13 below.

Table 4.10: Summary of t-test showing Mean Difference in Environmental Knowledge of Waste Management among Federal and State Colleges of Education Pre-service Teachers

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Federal College Pre-service Teachers Environmental Knowledge	53.592	415	.000	2.745	2.64	2.85
State College Pre-service Teachers Environmental Knowledge	60.400	415	.000	3.200	3.10	3.30

	N	Mean	Std. Deviation	Std. Error Mean
Federal College Pre-service Teachers Environmental Knowledge	416	2.75	1.045	.051
State College Pre-service Teachers Environmental Knowledge	416	3.20	1.080	.053

Source: Fieldwork, 2022

Table 4.10 presented a summary of t-test result demonstrating the mean difference in environmental knowledge of waste management among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed Federal College pre-service teachers' environmental knowledge (mean = 2.75, Std =1.045, $p < 0.05$) and state pre-service teachers' environmental knowledge (mean

= 3.20, Std = 1.080, p < 0.05). This implies that state college pre-service teachers contribute more to the observed differences.

Table 4.11: **Summary of t-test showing Mean Difference in Teachers Attitude towards Waste Management among Federal and State Colleges of Education Pre-service Teachers**

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Federal College Pre-service Teachers Attitude Towards Waste Management	86.474	415	.000	3.305	2.23	3.38
State College Pre-service Teachers Attitude Towards Waste Management	54.657	415	.000	2.704	2.61	2.80

	N	Mean	Std. Deviation	Std. Error Mean
Federal College Pre-service Teachers Attitude Towards Waste Management	416	3.31	.780	.038
State College Pre-service Teachers Attitude Towards Waste Management	416	2.70	1.009	.049

Source: Fieldwork, 2022

Table 4.11 above presented a summary of t-test result demonstrating the mean difference in attitude towards waste management among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference (p < 0.05). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-service teachers' attitude towards waste management (mean = 3.31, Std =.780, p < 0.05) and state pre-service teachers' attitude

towards waste management (mean = 2.70, Std = 1.009, $p < 0.05$). This implies that federal college pre-service teachers contribute more to the observed differences.

Table 4.12: Summary of t-test showing Mean Difference in Waste Practices among Federal and State Colleges of Education Pre-service teachers

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Federal College Pre-service Teachers Waste Practices	84.052	415	.000	3.048	2.98	3.12
State College Pre-service Teachers Waste Practices	86.904	415	.000	3.353	3.28	2.43

	N	Mean	Std. Deviation	Std. Error Mean
Federal College Pre-service Teachers Waste Practices	416	3.05	.740	.036
State College Pre-service Teachers Waste Practices	416	3.35	.787	.039

Source: Fieldwork, 2022

Table 4.12 presented a summary of t-test result demonstrating the mean difference in waste practices among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-service teachers' waste practices (mean = 3.05, Std =.740, $p < 0.05$) and state pre-service teachers' waste practices (mean = 3.35, Std = .787, $p < 0.05$). This implies that federal college pre-service teachers contribute more to the observed differences.

Table 4.13: Summary of t-test showing Mean Difference in Waste Management (reduce, reuse, recycle and disposal) among Federal and State Colleges of Education Pre-service teachers

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Federal College Pre-Service Teachers Waste Management	52.285	415	.000	2.702	2.60	2.80
State College Pre-Service Teachers Waste Management	68.146	415	.000	2.993	2.91	3.08

	N	Mean	Std. Deviation	Std. Error Mean
Federal College Pre-Service Teachers Waste Management	416	2.70	1.054	.052
State College Pre-Service Teachers Waste Management	416	2.99	.896	.044

Source: Fieldwork, 2022

Table 4.13 presented a summary of t-test result demonstrating the mean difference in waste management (reduce, reuse, recycle and disposal) among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-service teachers' waste management (mean = 2.70, Std =.1.054, $p < 0.05$) and state pre-service teachers' waste management (mean = 2.99, Std = .896, $p < 0.05$). This implies that state college pre-service teachers contribute more to the observed differences.

4.4 Discussion of Findings

In this study it was established that the most prevalent type of solid waste produced by pre-service teachers in Oyo Township was organic solid waste with weighted mean value of 3.29 which were more produced in the study location than the in-organic waste with weighted mean value of 2.92. This was determined by dividing solid waste into two groups which were organic and in-organic (see table 4.3). This result showed that pre-service teachers in Oyo Township produced more organic solid waste than in-organic waste. This could be as a result of being a school environment. Some solid waste common around this environment are food waste, paper, cardboard, green waste (grass clippings, hedge trimmings, branches, plants, flowers, leaves), pens, files, fruit wastes and so on.

The level of pre-service teachers' environmental knowledge of solid waste management (reduce, reuse, recycling and waste disposal) was also determined. Through the weighted mean, it was deduced that the level of environmental knowledge of pre-service teachers in Oyo Township was moderate (2.89) (see table 4.4). This is in line with a study carried out in Nigeria that examined the level of awareness, knowledge and practices of secondary schools students with regard to waste management in Nigerian educational institutions which showed that secondary school students were knowledgeable about waste problems on their school compounds, but still possessed poor waste management practices[1]. Another study on Waste Management in Urban Nyeri, indicated that the majority of the respondents were aware about the health hazards associated with incorrect waste management with the level of awareness being high in all the estates; however, there was a discrepancy between knowledge and correct practice, as only few households practiced correct methods of waste disposal (separated, stored into a receptor, deposited into a garbage

chamber/compost pit or used kerb side services)[2]. In a study, the majority of the respondents indicated that they had heard about WM in particular, recycling[3]. In a related study on the Economics of Waste Management of Kampala City, it was established that majority of the respondents had heard of the segregation of waste[4].

Based on the study targeting students of a selected hostel in Rajasthan University on the variables comprising of waste management knowledge, attitude and practices[5]. The finding indicated low, less favourable, and moderate in knowledge, attitude, and practice respectively; correlation of knowledge and attitude was absent, practice and knowledge indicated a substantial correlation.

A research was carried out to establish the knowledge and practices on biomedical waste in a population sample of health workers in health care institutions, a cross section study was employed that showed a limited percentage of health care workers, few had biomedical waste management training and skills[6].

A study on impact of community health awareness and intervention on knowledge, attitude, and behaviours on waste product management and disposal indicated vast knowledge on diseases and health risk associated with waste accumulation for the group that attended the training and education programmes, positive attitude on managing wastes, and improved waste handling practices which include recycling household wastes[6]. The observation showed an increase in community participation in cleaning and other environmental protection activities. Another study was conducted which showed that pre-service teachers who experienced environmental knowledge would transmit environmental attitudes and awareness to future generations[7]. Also, this group of individuals are aware that waste disposal in the drainage system can, cause environmental hazard, recycling waste items

help save the environment from hazards, recycling reduces the community dependence on landfill, and that avoiding single-use food and drink containers and utensils. The environmental knowledge of the levels of education, health education and sensitisation about waste management, sources of information about waste management and awareness of environmental laws regarding waste management are good at individual level and should be acquired by pre-service teachers because such will be passed down to their students in the future; which would affect the society at large positively. Therefore, environmental programmes or seminars in pre-service teacher education are important.

The result of the findings in this study on the attitude of pre-service teachers of solid waste management (reduce, reuse, recycling and waste disposal) in Oyo Township by judging from the weighed mean, showed that pre-service teachers in Oyo Township were indifferent (2.87) in terms of attitude towards waste management (reduce, reuse, recycling and waste disposal) (see table 4.5). This study showed that the respondents are in different to dumping waste in the gutter makes them feel bad because it shows poor waste management (waste disposal, reuse, reduce and recycle); those who make the environment dirty should be punished, and that if people continue to dump waste indiscriminately may lead to the experience of a major environmental catastrophe. This is in line with a Ghanaian study about attitude towards recycling of waste management showed no significant effect of gender, employment and educational statuses, on willingness to practice proper waste management (segregation and recycling)[8]. In another research study, the environmental attitudes, recycling habits, and relationship between attitudes and recycling habits was determined and it was found that the participants' attitudes were moderate[9].

A study focused on public attitudes towards reducing, reusing and recycling waste in the Makurdi Metropolitan area of Nigeria[10]. It was found that local authority strategy towards a sustainable hierarchy and federal government funding be forthcoming to make necessary infrastructure improvements and embrace public attitudes to waste reduction, reuse and recycling. Some community members prefer engaging in other personal issues like crime, unemployment, and managing the cost of living are more important to community members than a garbage-free community. Majority revealed that they would not waste their time collecting and disposing waste instead of engaging in income generating activities[11, 10]. Some revealed that they would not even waste time engaging in village meeting aimed at garbage management as many said they would rather go boozing. In terms of environmental psychology, researchers found the link between pro-environmental attitudes and recycling behaviour. Another study carried out in university area of Ogbomoso was in contrast to this study which had a positive attitude towards waste management that waste disposal into drains and around the surroundings is unhealthy and can be disastrous to health[12].

A study was conducted on waste disposal of waste management and the implication of the results was that the residents of Calabar South had very negative attitude towards waste management and disposal, while there was an influence of indiscriminate disposal of waste and the health status of the residents of Calabar South Local Government Area[13]. The study concluded that because of the negative attitude the residents of Calabar South have towards the management and disposal of their waste, it has some significant influence on their health status.

In a study, it was investigated whether there is a relationship between environmental attitudes and behaviour of a group of students in Ankara[14]. The study revealed that great

number of secondary school students from four schools in Ankara have low environmental behaviours although their attitudes toward the environment were high. It was advised that compulsory environmental education should be integrated into school curricula in order to increase 'participation in environmental activities'[14]. A study conducted in Owerri community Imo state residents in Nigeria showed that majority of the respondents were aware of the waste management with majority showing a positive attitude toward managing wastes and protection of the environmental health[15].

Further, this study showed that dust bin is the most dominating solid waste disposal practice among pre-service teachers in Oyo Township. This was followed by open burning of dry waste, incineration, dump pits, and landfill site respectively; while composting waste was the least waste disposal practice among pre-service teachers in Oyo Township (see table 4.6). A study conducted in Owerri community Imo state residents in Nigeria was contrary to this study which showed that open dumping and burning was practiced which forms the two poor waste management approaches; and wheel barrow transportation stood out as the most famous means of waste transportation to the dumping site[15]. A review of waste management practices investigated the impact on human health in community waste, and effect of bio aerosol exposure from sewage plant treatment[16]. Results found that community waste had adverse impact outcome on health for the population neighboring dumping sites and nuclear installation. A study also found that, the main waste disposal practices in wastes have a significant influence on environmental hygiene and human health[13].

The result of this findings showed the dominating solid waste management (reduce, reuse and recycling) among pre-service teachers in Oyo Township. It showed that reducing

waste is the most dominating solid waste management among pre-service teachers in Oyo Township which was followed by reuse and recycling respectively (see table 4.7).

A study on household knowledge, attitudes and practices on the separation and recycling of waste indicated that although the public is aware of waste separation and recycling practices, they did not participate in such initiatives[17]. However, awareness and knowledge of waste disposal is influenced by many factors as pointed out in a study on household knowledge, attitudes and practices in waste segregation and recycling in urban Kampala[4]. It indicated that the participation in waste separation activities depended on the level of awareness of recycling activities in the area, household income, educational level and gender[4]. Also, a study on the waste management awareness knowledge and practices of secondary school teachers in Ogun state, Nigeria showed that teachers were aware and knowledgeable about waste management even though they possessed negative waste management practices; although, there seemed to be appreciable awareness and knowledge about waste disposal among the respondents, most of them were only aware of the crude and traditional methods and were oblivious of the modern methods such as incineration and recycling[1]. A study on the reuse of solid waste shows that to redeem the value of waste, either by reintegrating it with the production system somehow, or by recognizing the use value of certain objects[18].

This study illustrates that, the reduction of solid waste relates to the efficient minimization of solid waste production, waste prevention and diversion from the waste stream; leaving little solid waste for dumping at the landfill site. One of the most striking findings of this study was that, all kinds of solids were dumped in the bins when declared unwanted by the institutions; and, there is no separation of solid waste at source. The

dumping of solid waste into containers remained the common option for solid waste disposal. The conventional practices of solid waste generation and disposal become twofold environmental issues very critical across the globe and a departure from the tenets of the '3Rs', particularly, waste reduction as practiced by the respondents in this study. Suffice to say that this situation attracts disease-carrying pests and creating grounds for serious public and environmental health hazards[8]. When full, towing vehicle lift the metal bins and empty the content at the dumping site. Presently, there is no strategy in place to reduce the generation of solid wastes at source. There is also no sorting of solid waste either at the collection or dust bin provided by the school management. Hence, no specific measure is taken by the management to directly reduce the volume of solid waste it is only done by individuals that are aware of reduction of solid waste at the source; and cleaners employed in the school system for their own personal gain.

Reusing of solid waste involves water plastics/bottles, and papers are been collected for sale by the individual cleaners within the school for their own personal gain through reuse. Also, in areas close to the school some scavengers were found at the dumping site combing the waste for reuse materials. The most classic example of reuse is provided by the reuse of plastic bottles, mainly, drinking water and coca cola bottles for re-sale or direct usage for packaging locally made non-alcoholic drink, the very popular "sobo" drink or locally made liquid soap.

The recycling of solid waste into new products is happening on a small scale. The recycling of metal scrap was common among the blacksmith to manufacture simple tools such as hoes, pick axe, coal pots for cooking, "gong", hammers and knives[4]. Electrical welders also depend on scrap metals for the making of metal doors, gates and beds. Others

gather the scrap metals for re-sale for onward transportation. A study illustrates that, the first R, reduction of solid waste relates to the efficient minimization of solid waste production, waste prevention and diversion from the waste stream; leaving little solid waste for dumping at the landfill site[8].

The findings of this study further showed the summary of regression analysis on the influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township, result showed a ($p < 0.00$) meaning there was significant combined influence, therefore, the null hypothesis was rejected at 0.05 level of significance. The result also gave (Adj. $R^2 = 0.316$) meaning that 32 percentage of the variation is accounted for when the independent variables pre-service teacher's environmental knowledge, attitude, and practices were considered jointly (see table 4.8).

Further, this study showed that the summary of regression analysis of relative influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township. The result showed that waste management practices contributed the most to solid waste management among pre-service teachers in Oyo township ($\beta = .497$, $p < 0.05$). This was followed by environmental knowledge ($\beta = .202$, $p < 0.05$) and attitude of pre-service teacher ($\beta = .144$, $p < 0.05$) respectively. Hence, the null hypothesis was rejected at 0.05 level of significance (see table 4.9).

A research which is in line with the findings of this study was conducted to establish the effect of attitudes, practices, and knowledge on waste management on Polytechnic and university student, the findings indicated that majority of the students indicated knowledge to be satisfactory, majority attitude on strategic waste management issues; while few depicted

satisfactory levels in practice[19]. The relationship depicted a significant interaction between knowledge and attitude of student prediction.

Also, a cross-sectional study was conducted on the knowledge, attitude, and practice of waste disposal and recycling; the findings showed that students had a moderate knowledge of waste disposal[20]. Moreover, their knowledge did not influence them to practice segregation of waste.

Further, a study on the knowledge, attitude, and practices of students in the secondary school towards waste management in Ibadan, Nigeria found that the students had a relatively moderate level of knowledge, attitude, and practice of waste management[21]. However, the evidence of those who used indiscriminate waste disposal methods like open dumping and burning was still higher. The findings also showed that students' gender, age, and class significantly influenced their level of awareness, knowledge, and practices of waste management. Also, another study conducted to find out the awareness and sensibility levels of campus people about environmental problems; the result revealed that the respondents showed a moderate level of awareness and sensibility about the environmental problems; but despite their knowledge of the problems, the subjects of the study never showed interest in them[20].

The KAP survey which in line with the findings of this study was done in a research to determine the knowledge, attitude, and practices of college students, specifically on waste management and recycling. In general, the study found out that majority of undergraduate students from LSPU Los Baños Campus, during the 2nd Semester, A.Y. 2015-16, had satisfactory knowledge and attitude[22]; however, less than half had satisfactory practice level on several items on material recycling and participation in environmental programmes. This

suggests that most undergraduate students, at the time of the survey were somehow aware of the importance as to proper wastes management and recycling and they also exhibit good attitude towards these matters; however, relatively few students had exemplary practice level. Another, study also surveyed students from secondary schools, universities, and colleges in Nigeria which revealed unsatisfactory knowledge level on environmental issues among student-respondents, but they showed good perception ratings. The students were at least, conscious but they could not "explain on why" environmental problems continue to exist in their community[10].

Another study explored the village KAP on waste management and the results showed high awareness and favourable attitudes on waste-related issues and topics, among the surveyed members of the communities; interestingly, the respondents also engaged in favourable practices on waste segregation[23]. The study revealed that the students' knowledge and attitude were positively correlated with their level of practice. The tendency of the students to minimise the use of materials was highly associated with satisfactory knowledge and attitude ratings. Reuse of wastes including plastic/glass bottles, cans, and paper and rainwater was also associated with satisfactory knowledge rating, but not with attitude; whereas, preference to use rechargeable batteries over the disposable types was significantly related to satisfactory attitude ratings.

A great variety of studies about attitudes and knowledge have procured a positive and significant relationship between the above variables. A research was studied on how levels of knowledge and attitude towards nature conservation could be raised to positively affect visitor education[19]. For all measured concepts, the findings indicate a positive relationship between waste knowledge, attitude, and practices of waste management. High positive

correlations between knowledge and practice level were also reported, the respondents with higher knowledge scores were more likely to exhibit good practice on waste management[24].

Similarly, a study involving adolescents showed that pro-environmental attitude positively predicts pro-environmental behaviours[14]. On the other hand, somewhat contrasting findings were reported in an environmental-KAP survey that involved students from 16 higher learning institutions; it was found that both knowledge and attitude did not necessarily lead to sustainable environmental practices which highlighted that complexity of the relationships between students' KAP towards sustainable environment[25]. Another findings were reported in a knowledge-practice level assessment done in Ogun State, Nigeria, it was revealed that secondary school students from the sampled zones were relatively aware of waste problems in their school compounds, but the same students possessed poor waste management practices[26].

Further, several studies have been conducted on knowledge, attitude, practices of waste management. A research was designed for assessing Owerri community Imo state residents in managing wastes in Nigeria, the findings indicated a respondent awareness of waste management and a positive attitude towards waste management[15]. A study indicated that there was low attitude towards waste management by university students, the findings revealed no correlation between waste management and knowledge, attitude, and practices while there was a significant correlation between knowledge and practices in waste management[27].

Perception and attitude on disposal of wastes study in Tamale Metropolis, Ghana, depicted that household attitude have significant impact on the motives to use dustbins in the future and in the review on practices in managing wastes and their effect on human and

environmental health, indicates that many of the inhabitants neighbouring the waste dumping sites suffer adverse effects on their health as well as environmental health[28].

Further, the findings showed a summary of t-test result demonstrating the mean difference in environmental knowledge of waste management among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed Federal College pre-service teachers' environmental knowledge (mean = 2.75, Std =1.045, $p < 0.05$) and state pre-service teachers' environmental knowledge (mean = 3.20, Std = 1.080, $p < 0.05$). This implies that state college pre-service teachers contribute more to the observed differences (see table 4.10). The moderating variable of the school type showed that the mean difference in level of environmental knowledge of waste management among federal and state colleges of education pre-service teachers in Oyo Township that there is a significant difference between the federal college pre-service teachers' level of environmental knowledge and state pre-service teachers' level of environmental knowledge. This implies that state college pre-service teachers contribute more to the observed differences (see table 4.10) that is, Emmanuel Alayande college of education pre-service teachers' level of environmental knowledge was high compare to what their counterparts in Federal College Oyo special exhibited. One can say it has its cleanness impact on the school environments if compared.

Also, a summary of t-test result demonstrating the mean difference in attitude towards waste management among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-

service teachers' attitude towards waste management (mean = 3.31, Std =.780, $p < 0.05$) and state pre-service teachers' attitude towards waste management (mean = 2.70, Std = 1.009, $p < 0.05$). This implies that federal college pre-service teachers contribute more to the observed differences (see table 4.11). The mean difference in attitude towards waste management among federal and state colleges of education pre-service teachers in Oyo Township showed a significant difference. The result further revealed that federal college pre-service teachers' attitude towards waste management is high when compared to their counterparts in state college pre-service teachers' attitude towards waste management. This implies that federal college pre-service teachers contribute more to the observed differences. Even though the federal college Oyo special pre-service teachers has a positive attitude towards solid waste management it does not reflect in their school environment. Although, this could be has a result of the school being funded by the federal government.

A summary of t-test result demonstrating the mean difference in waste practices among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-service teachers' waste practices (mean = 3.05, Std =.740, $p < 0.05$) and state pre-service teachers' waste practices (mean = 3.35, Std = .787, $p < 0.05$). This implies that federal college pre-service teachers contribute more to the observed differences (see table 4.12). A summary of t-test result demonstrating the mean difference in waste practices among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference that the federal college pre-service teachers' waste practices when compared with

the state pre-service teachers' waste practices. This implies that federal college pre-service teachers contribute more to the observed differences.

Lastly, the findings showed a summary of t-test result demonstrating the mean difference in waste management (reduce, reuse, recycle and disposal) among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-service teachers' waste management (mean = 2.70, Std =.1.054, $p < 0.05$) and state pre-service teachers' waste management (mean = 2.99, Std = .896, $p < 0.05$). This implies that state college pre-service teachers contribute more to the observed differences in solid waste management (see table 4.13). The mean difference in waste management (reduce, reuse, recycle and disposal) among federal and state colleges of education pre-service teachers in Oyo Township showed a significant difference ($p < 0.05$) which revealed that federal college pre-service teachers' waste management (mean = 2.70, Std =.1.054, $p < 0.05$) when compared with state pre-service teachers' waste management (mean = 2.99, Std = .896, $p < 0.05$) implies that state college pre-service teachers contribute more to the observed differences in waste management in the study area.

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Chapter Five

Conclusion

5.1 Summary of Findings

This study showed the most prevalent type of solid waste produced by pre-service teachers in Oyo Township. In determining this, solid waste was divided into two which were organic and in-organic. The result showed that organic solid waste with weighted mean value

of 3.29 which were more produced in the study location than the in-organic waste with weighted mean value of 2.92.

The findings showed the level of pre-service teachers' environmental knowledge of solid waste management (reduce, reuse, recycling and waste disposal). Judging from the weighted mean, it was deduced that level of pre-service teachers in Oyo Township was moderate (2.89).

Also, the findings showed the attitude of pre-service teachers and solid waste management (reduce, reuse, recycling and waste disposal) in Oyo Township. Judging from the weighed mean, it was concluded that pre-service teachers in Oyo town were indifferent (2.87) in terms of attitude towards waste management (reduce, reuse, recycling and waste disposal).

Further, the findings showed that the dominating solid waste disposal practices among pre-service teachers in Oyo Township was dust bin. This was followed by open burning of dry waste, incineration, dump pits, and landfill site respectively; while composting waste is the least waste disposal practice among pre-service teachers in Oyo Township. Also, the finding showed that the most dominating solid waste management (reduce, reuse and recycling) among pre-service teachers in Oyo Township was reducing waste which was followed by reuse and recycling respectively.

The summary of regression analysis on the influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township was that the result showed a ($p < 0.00$) meaning there was significant combined influence, therefore, the null hypothesis was rejected at 0.05 level of significance. The result also gave (Adj. $R^2 = 0.316$) meaning that 32 percentage of the variation is accounted for

when the independent variables pre-service teachers' environmental knowledge, attitude, and practices were considered jointly.

Also, the findings of the study showed the summary of multiple regression analysis of relative influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township. The result showed that waste management practices contributed the most to solid waste management among pre-service teachers in Oyo Township ($\beta = .497$, $p < 0.05$). This was followed by environmental knowledge ($\beta = .202$, $p < 0.05$) and attitude of pre-service teacher ($\beta = .144$, $p < 0.05$) respectively. Hence, the null hypothesis was rejected at 0.05 level of significance.

Further, the findings showed a summary of t-test result demonstrating the mean difference in environmental knowledge of waste management among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed Federal College pre-service teachers' environmental knowledge (mean = 2.75, Std =1.045, $p < 0.05$) and state pre-service teachers' environmental knowledge (mean = 3.20, Std = 1.080, $p < 0.05$). This implies that state college pre-service teachers contributed more to the observed differences (see table 4.10).

Also, a summary of t-test result demonstrating the mean difference in attitude towards waste management among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-service teachers' attitude towards waste management (mean = 3.31, Std =.780, $p < 0.05$) and state pre-service teachers' attitude towards waste management (mean = 2.70, Std = 1.009, p <

0.05). This implies that federal college pre-service teachers contributed more to the observed differences (see table 4.11).

A summary of t-test result demonstrating the mean difference in waste practices among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-service teachers' waste practices (mean = 3.05, Std =.740, $p < 0.05$) and state pre-service teachers' waste practices (mean = 3.35, Std = .787, $p < 0.05$). This implies that federal college pre-service teachers contributed more to the observed differences (see table 4.12)

Lastly, the findings showed a summary of t-test result demonstrating the mean difference in waste management (reduce, reuse, recycle and disposal) among federal and state colleges of education pre-service teachers in Oyo Township. The result showed a significant difference ($p < 0.05$). As a result, at 0.05 level of significance, the null hypothesis was rejected. The result further revealed federal college pre-service teachers' waste management (mean = 2.70, Std =.1.054, $p < 0.05$) and state pre-service teachers' waste management (mean = 2.99, Std = .896, $p < 0.05$). This implies that state college pre-service teachers contributed more to the observed differences (see table 4.13).

5.2 Conclusion

This study investigated Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township. Solid waste management was understood as supervised handling of waste materials from source through recovery processes to disposal; and, it involves control of generation, storage, collection,

transportation, processing and disposal of solid waste with the aim of protecting environmental quality, human health and preservation of natural resources. It is done along the lines of a systematic utilisation of reducing, reusing and recycling.

The study was able to ascertain pre-service teachers' types of solid waste produced; determine the level of pre-service teachers' environmental knowledge of solid waste management (reduce, reuse, recycle and waste disposal); examine the extent to which pre-service teachers' attitude influences solid waste management (reduce, reuse, recycle and waste disposal); ascertain the pre-service teachers' practices of solid waste disposal; determine the combined influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management (reduce, reuse, recycle and waste disposal); examine the relative influence of Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management (reduce, reuse, recycle and waste disposal); and lastly the school type difference in Pre-Service Teachers' Environmental Knowledge, Attitude and Practices of Solid Waste Management in Oyo Township was determined. Reduce emphasizes any attempt at points of production and consumption aimed at reducing the quantity of waste generated. Reuse means the use of substances repeatedly, which includes protracted use of repaired good or their parts. Recycling points out to the conversion of waste to resources, such as material recycling and recycling by energy resources. To enhance the effectiveness and efficiency of the solid waste management the emphasis therefore should be placed on focusing primarily on sorting at source and '3Rs' – 'reducing, reusing and recycling' which are very important in all schools. Solid waste disposal should be the last resort but not the prime option in waste management practices.

5.3 Recommendations

Based on the findings of this study the following recommendations were made:

1. The proper environmental knowledge/education and awareness of the pre-service teachers should be advocated in schools and by extension to the public;
2. The individual pre-service teachers and by extension the public should develop a positive attitude towards solid waste management and having a clean environment should be seen as a collective responsibility;
3. The pre-service teachers should be encouraged and educated on solid wastes sorting before dumping; and also there should be provision of waste bins in different colours for sorting solid waste accordingly;
4. The provision of more waste bins by the school management and by extension the government should be advocated;
5. The school management and the government should make frantic efforts to promote the more sustainable practice of “3R” (Reduce, Reuse and Recycling) in all schools and cities;
6. Solid waste production in the schools are inevitable and so the pre-service teachers should be encouraged to practice proper solid waste disposal at all times in designated place, and desist from indiscriminate dumping of solid waste "anywhere and everywhere";
7. The ‘3Rs’ should be seen by government as policy tool as recommended by the sustainable development goal 6 and means of resources; and
8. The school management must see to the regular collection of solid waste as the need arise.

Therefore, if the above recommendations are well taken and implemented, it will bring about effective management of solid waste generated and hence ensure a clean environment and curb any possible outbreak of disease.

5.4 Suggestion for Further Studies

This study investigated pre-service teachers' environmental knowledge, attitude and practices and solid waste management in Oyo Township. Other studies can investigate the variables in some other geographical location apart from Oyo Township or colleges of Education. For instance, Oyo State, Northwest Nigeria or Nigeria as a whole. Also, other researchers may investigate other variables such as: effective waste management as a tool for achieving sustainable development; pre-service teachers' attitude towards environmental issues; perception of teachers' knowledge and attitude towards environmental issues; knowledge, attitudes and practices of traders towards solid waste management in major markets.

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Appendix 1

Department of Arts and Social Science Education,
Faculty of Arts and Education,
Lead City University, Ibadan

Environmental Knowledge, Attitude and Practices on Waste Management Questionnaire (EKAPWMQ)

I am a Postgraduate student of Department of Arts and Social Science Education, Faculty of Arts and Education, Lead City University, Ibadan. I am writing a thesis on **Pre-service teachers' environmental knowledge, attitude and practices of solid waste management in Oyo Town."** I kindly request your assistance by availing time to respond to the

questionnaire. All data collected will be treated in strict confidence and used only for research purpose. Your co-operation will be highly appreciated.

Yours Faithfully,

Kafayat Olabisi ADEDIRAN

Section A: Demographic Information

Instruction: Please take time to answer the following question items and tick (√) as appropriate.

15. Name of College _____

16. Gender: (a) Male ( ) (b) Female ( )

17. Age: (a)16 years and below ( ) (b) 17-21 years ( ) (c) 22-26 years (d) 27 years and above ( )

Section B: Types of Waste Produced

Instruction: Please tick (√) the type of waste mostly produced by you as a student

Key: Mostly = 4, Sometimes = 3, Rarely = 2 and Never = 1

S/N	Items	Mostly	Sometimes	Rarely	Never
	Organic waste (Biodegradable waste)				
18.	Food left overs				
19.	Used Papers and folders				
20.	Pens				
21.	Pieces of clothes				
22.	Fruit and vegetable peels				
	Inorganic Waste (Non-biodegradable wastes)				
23.	Plastics of different types				

24.	Empty bottles used for drinks				
25.	Glasses, Tin and Metals				
26.	Batteries				
27.	Plates				
28.	Spoons				
29.	Bags				
30.	Book cases				
31.	Nylons				

Section C: Environmental Knowledge on Waste Management (EA)

This subsection will be assessing information on level of environmental knowledge of waste management.

Instruction: Please tick (√) the question items as appropriate.

Key: Very High (VH) = 4, High (H) = 3, Low (L) = 2, Very Low (SD) = 1

S/N	**Items** My level of environmental knowledge about …….	**VH**	**H**	**L**	**VL**
17.	Waste disposal in the drainage system causing environmental hazard				
18.	Principles of waste minimisation by segregation				
19.	The complications of improper waste disposal				
20.	The importance of using protective clothing (gloves, appropriate cloths, masks, etc) for handling waste				
21.	The use of rechargeable batteries				
22.	Repairing items instead of throwing them away				
23.	Reusing to reduce waste handling and disposal cost				
24.	Reusing items to save landfill spaces				
25.	Waste recycling in my community to save landfill spaces				
26.	Recycling waste items to help save the environment from hazards				
27.	Recycling reduces the community dependence on landfill				
28.	Recycling containers near my house/school to save the environment				
29.	Avoiding single-use food and drink containers and utensils				
30.	Buy in bulk to reduce packaging dirtying the environment				

31.	Compositing solid waste				
32.	Curbing my use of paper through mail, receipts magazines e.t.c				

Section D: Attitude of waste management (EA)

Instruction: Please tick (√) the question items as appropriate.

Key: Strongly Agreed (SA) = 4, Agreed (A) = 3, Disagreed (D) = 2, Strongly Disagreed (SD) =1

This subsection is concerned with assessing attitude and its relationship on waste management.

S/N	Items	SA	A	D	SD
21.	Dumping waste in the gutter makes me feel bad because it shows poor waste management (waste disposal, reuse, reduce and recycle)				
22.	Those who make the environment dirty should be punished				
23.	If people continue to dump waste indiscriminately, we will soon experience a major environmental catastrophe				
24.	Everybody, including students should learn how to protect the environment				
25.	I avoid single-use of food and drink containers and utensils to reduce landfill waste disposal				
26.	I must ensure that I and others disposed wastes properly				
27.	Recycling of waste items should be encouraged				
28.	Indiscriminate littering of wastes and urination around the school premises contributes to environmental hazards				
29.	I must take action voluntarily to keep my environment clean by using dust bin as appropriate				
30.	Composting of food waste should be encouraged to reduce landfill				
31.	I am worried about how waste are handled around my school premises				
32.	Students should cultivate the habit of reducing waste they produced through reuse				
33.	It displeases me on how my fellow students regard and handle waste in the classroom and school premises				
34.	I am satisfied with the way my school management handles waste				
35.	I often remind other students to separate and drop waste appropriately in the waste bin				
36.	I often share information on waste management (waste disposal, reuse, reduce and recycle) with other students				
37.	I believe that improper waste disposal is a threat to				

	Environment				
38.	Waste management (waste disposal, reuse, reduce and recycle) is my responsibility and not only that of the school management				
39.	I am responsible for reminding other students on proper waste disposal (pick and dispose waste)				
40.	It is important to read and share information on waste management (waste disposal, reuse, reduce and recycle) with other Students				

Section E: Waste Practices of waste management

Instruction: Please tick (√) the question items as appropriate.

Key: Mostly = 4, Sometimes = 3, Rarely = 2 and Never = 1

This subsection is concerned with assessing practices of Solid waste Disposal

S/N	Items	Mostly	Sometimes	Rarely	Never
	Practices of Solid Waste Disposal				
7.	Composting waste				
8.	Open burning of dry waste				
9.	Incineration				
10.	Dust bins				
11.	Dump pits				
12.	Landfill Site				
13.	Recycling				
14.	Reuse				
15.	Reduce				

Bio-data

A. Personal Data

1. Full Name: Kafayat Olabisi ADEDIRAN

Home Address: Plot 4 and 6. Cresent Villa, Gbenga Oyekola Scheme. Offa Meta, Oyo.

E-mail Address: adedirankafayat2020@gmail.com

Phone Number: 08165851770

2.	**Date and Place of Birth:**	30th April, 1982, Suleja/Abuja
3.	**Nationality:**	Nigerian
4.	**Name and Address of Next of Kin:**	Alhaji T. L. Adediran, Plot 4 and Cresent Villa, Gbenga Oyekola Scheme. Offa Meta, Oyo.

B. Educational Background

Educational Institutions attended with dates and Qualifications obtained

	Educational Institutions	**Qualification Obtained**	**Date**
1)	Lead City University, Ibadan, Oyo state	M. Ed (in view)	2020-till date
2)	Ekiti State University, Ado-Ekiti, Nigeria	B.Sc (B.Ed)	2014
3)	Oyo State College of Education now (Emmanuel Alayande College of Education)	NCE	2001-2004
4)	Government Girl Secondary School Ungwan Muazu, Kaduna State	NECO	1994-2000
5)	Aunt Nica's Nursery and Primary School, Kaduna State	PSLC	1988-1994
6)	Federal College of Education (Special), Oyo	Computer Training	2015
7)	Digital Bridge Institute (ADAPTI)	Computer Training	2016
8)	ICDL Africa	Computer Training	2020

C. Working Experience with Dates:

1.	Federal Teachers' Scheme (F.T.S) (Class teacher) L.A Primary School, Jabata, Oyo	2006-2007
2.	Oyo State Teaching Services Commission (TESCOM), Ibadan Durbar Grammar School, Oyo	2009-2014
3.	Emmanuel Alayande College of Education Lecturer	2015-till date

D. Awards and Fellowships (If any): Nil

E. Membership of Academic Professional Bodies:

1. Teachers Registration Council of Nigeria (TRCN)
2. Social Studies Association of Nigeria (SOSAN)

F. Publications:

1. **Notable scholarly or Professional Accomplishments:** Nil
2. **Major Conferences or Workshops Attended:**

K. O. Adediran: Gender Equality and Choice of Career: A Case Study of Tertiary Institution Students in Oyo Town, 7th Annual International Interdisciplinary Conference on Raising Girl's Ambition (RAGA 2021), Lead City University (2021)

Signature **Date**

University Compliance Certification

This is to certify that this thesis by Kafayat Olabisi ADEDIRAN in the Department of Arts and Social Science Education (Social Studies Education Unit), Faculty of Arts and Education, Lead City University, Ibadan, is in full compliance with the approved University Format and Style.

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Signature Date