MUNICIPAL SOLID WASTE MANAGEMENT IN ENUGU: THE CHALLENGE OF PUBLIC PARTICIPATION

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Abstract

Public particpation in environmental waste disposal is critical to the success of environmental sanitation agencies in ensuring a healthy environmental quality. This study investigated the compliance of Enugu residents with the directives of the Enugu State Waste Management Authority (ESWAMA). Results showed that residents significantly complied with all such directives, namely taking wastes to neighbourhood dustbin (75.5 %), bagging of waste meant for neighbourhood dustbin (77.5 %), cleaning the neigbourhood on the environmental sanitation day (usually one Saturday in a month) (77.8 %), and payment of sanitation rates (77.4 %).

INTRODUCTION

Solid wastes constitute a global problem because they are generated almost every minute in homes in different parts of the world. Statistics show that the United States of America generates

19 % of the world's total rubbish waste, despite their improved collection and disposal methods. Japan has 44%, Germany 2.9%, Korea 2.9%, Britain 1.8%, Canada 1.8%, France 1.5%, Australia 1.1%, and the rest of the world has 25%. Countries with high waste generation also have high waste problems. It is estimated that 30-50 % of solid wastes generated within the urban centre remain uncollected. This leads to solid wastes accumulating on wasteland, streets, blocking the road and drainage channels with garbage. Other effects include fire outbreak, serious health hazard for children playing on the site (Okoroafor, 2005).

Globally, there is an increasing awareness of environmental planning and management. Municipal Solid Waste (MSW) management systems are becoming more complex in many countries with the move from landfill-based to resource recovery-based solutions, following the setting of international and national targets to divert wastes from landfill and to increase recycling and recovery rates. In developing countries, there is a much higher proportion of organics and considerable less plastic than in developed countries. The large amount of organic material makes the waste denser, with greater moisture and smaller particle size. Secondly, technologies used in industrialized countries are often inappropriate for developing countries. Even garbage trucks are less effective in developing countries because of the much heavier, wetter and more corrosive quality of their burden. Other technologies, such as incinerators, are often far too expensive to be applied in poor nations. Thirdly, cities and towns of developing countries are characterized by unplanned, haphazardly constructed, sprawling slums with narrow roads that are inaccessible to collection vehicles. Finally, there is often a much smaller stock of environmental and social capital in developing countries. People are unaware or uncaring of cradle-to-grave solid waste management needs, being more concerned with more immediate problems, such as disease and hunger (Ajadike, 2001).

Some studies have confirmed that in developed countries, the system of solid waste collection and disposal is efficient and so effort is concentrated on aspects like recycling. Authorities in developed countries have noted that the compositions of solid wastes vary, and therefore, resource recovery and recycling cannot be accomplished without the sorting of wastes into various components. Sorting and separation of solid wastes would be done manually or mechanically, depending on the volume of waste involved. Mechanical sorting is more expensive and is undertaken in developed countries. These wastes can be sorted at their sources of generation where they could easily be handled before collection by waste trucks (Sada and Odennerho, 1988).

According to Okoye (2008), the public waste management authorities do not measure up to the expectations of the citizens, as proved by the prevalence of wastes in all nooks and crannies of the cities. This poor performance in the collection and disposal of wastes can be traced to the nature of wastes generated, very few environmentally controlled disposal sites, often futile official efforts to develop recycling, financial constraint, inadequate infrastructure, high rate of population growth, and poor public perception or awareness.

To succeed in waste management for healthy environmental quality, the public waste management agencies in Nigeria need the participation of residents in areas of taking wastes to designated neighbourhood dustbin, proper waste bagging, cleaning the environment on environmental sanitation day (usually one Saturdy in a month), and payment of sanitation rates. To improve on public participation, ESWAMA began to action non-compliance by instituting a special court for quick dispensation of justice in this regard.

Aim and objectives of the study

This study was aimed at assessing the level of response and participation in solid waste disposal by residents of Enugu city. The specific objectives of the study were to assess the level of public compliance with ESWAMA directives on:

1. Taking wastes to designated neighbourhood dustbin.
2. Waste bagging.
3. Cleaning the neighbourhood on environmental sanitation days (usually one Saturday in a month).
4. Payment of sanitation rates.

Hypotheses

Null hypotheses formulated to guide the study were:

1. Residents of Enugu city do not comply significantly with ESWAMA directive on taking wastes to neighbourhood dustbins.
2. Residents of Enugu city do not comply significantly with ESWAMA directive on bagging the wastes meant for neighbourhood dustbins.
3. Residents of Enugu city do not comply significantly with ESWAMA directive on cleaning the neighbourhood on environmental sanitation days (usually one Saturday in a month).
4. Residents of Enugu city do not comply significantly with ESWAMA directive on payment of sanitation rates.

Research questions

Do residents of Enugu city significantly comply with ESWAMA directive on:

1. taking wastes to neighbourhood dustbins?

2. bagging the wastes meant for neighbourhood dustbins?
3. cleaning the neighbourhood on environmental sanitation days (usually one Saturday in a month)?
4. payment of sanitation rates?

Significance of the study

By generating and documenting data on public participation in municipal solid waste management in Enugu city, this study will benefit planners, ploicy makers, administrators, waste management agencies, the academia and all stakeholders on environmental management. It will provide the much-needed data for capacity building for sustainable municipal solid waste disposal management in Enugu city, which will serve as a model for other cities in Nigeria. This will help to improve public participation in waste management and achieve a better environmental quality for the benefit of all.

Scope and limitation of the study

The study examined public participation in solid waste disposal in Enugu. It concentrated on the municipal solid waste only. Liquid waste, such as sludge, was not covered. Environmental problems, like air pollution, soil contamination and industrial wastes, were not covered.

REVIEW OF RELATED LITERATURE

Conceptual framework

Early concepts of waste disposal

Rubbish has long ago been disposed of, since it is in human nature to use up and dispose of waste. However, with the advent of industrial revolution, the disposal of rubbish increased because people working in factories began to cluster to form cities. Before that, population was sparse and people were disposing of their refuse in their farm lands. During the first century of the industrial revolution, the volume of waste produced in the United States was relatively small and could be handled by a concept of "Dilute and Disperse". Factories were built near rivers because the water provided a number of benefits, including easy transport of materials by boat, sufficient water for processing and cooling, and easy disposal of waste into the river. With few factories and a sparse population, dilute and disperse seemed to remove the waste from the environment. With more industries and urbanization, the concept of dilute and disperse became inadequate. A new concept known as "concentrate and contain" became popular. This means that the waste may be packed in a container, like drums, and contained. However, the problem with this is that the contents can leak when the container breaks, thereby allowing the waste to escape (Adedibu, 1988).

Waste disposal sites are necessary if society is to function smoothly. However, nobody wants to live near a waste site, be it a sanitary landfill for municipal waste, an incinerator that burns urban waste or a hazardous waste disposal operation for chemical material. The largest wastes disposal site in the world is located on a 1,500-Hectare site on Staten Island, New York. This facility is known as Fresh Kills and accepts approximately 15,000 metric tons/day of municipal and commercial waste collected in the city of New York (about half the city's waste) and is expected to accept up to 20,000 tons/day. Yet, this colossus of waste disposal site will not be able to contain any more waste after years. Indeed, the problem of solid waste disposal is enormous.

Modern concepts of waste disposal

The environmentally preferable concept with respect to waste management is to consider wastes as resources out of place. We may not be able to recycle and reuse everything, but the increasing cost of raw material, energy, transportation and land will make it financially feasible to reuse and recycle more resources. This is what is called industrial ecology – the industrial society functions more like an ecological system, where waste from one part of the system will be a resource for another part (Sada and Odennerho, 1988). Some of the modern concepts of waste disposal are highlighted below.

The integrated waste management (IWM)

This new concept is best defined as a set of management alternatives, including reuse, source reduction, recycling, composting, landfill, and incineration. The three R's of IWM are reduce, reuse and recycle. Their ultimate objective is to reduce the amount of urban and other wastes that must be disposed of in landfills, incinerators and other waste management facilities. A study of the waste stream in areas that practice IWM technology suggests that the weight of urban refuse disposed of in landfills or incinerated could be reduced by at least 50%. This may get up to as much as 70% (Mabogunje, 1990).

On-site disposal

A common on-site disposal method in urban areas is the mechanical grinding of kitchen food wastes. Garbage disposal devices are installed in the waste-water pipe system at the kitchen sink, and the garbage is ground and flushed into the sewer system. This effectively reduces the amount of handling and quickly removes food waste. Final disposal is transferred to sewage treatment plants, where solids remaining as sewage sludge still must be disposed of (Mabogunje, 1990).

Composting and anaerobic digestion

Waste materials that are organic in nature, such as plant materials, food scraps, and paper products, are increasingly being recycled.

These materials are put through a composting and/or digestion system to control the biological process to decompose the organic matter and kill pathogens. The resulting stabilized organic material is then recycled as mulch or compost for agricultural or landscaping purposes. This is a popular technique in Europe and Asia, where intense farming creates a demand for the compost. A major drawback of composting is the necessity to separate organic materials from other waste. Therefore, it is probably economically advantageous only when organic material is collected separately from other waste. Nevertheless, composting is an important component of IWM. There are a large variety of composting and digestion methods and technologies varying in complexity from simple windrow composting of shredded plant materials to automated enclosed-vessel digestion of mixed domestic waste. These methods of biological decomposition are differentiated as being aerobic in composting methods or anaerobic in digestion methods, although hybrids of the two methods also exist (Pidering, 1994).

The Green Bin program, a form of organic recycling used in Toronto, Ontario and surrounding municipalities, including Markham, Ontario, Canada, makes use of anaerobic digestion to reduce the amount of garbage shipped to Michigan in the United States. This is the facet of the 3-stream waste management system that has been implemented in the city and is another step towards the goal of diverting 70% of current waste away from the landfills. Green Bins allow any organic waste that in the past would have formed landfill waste to be composted and turned into nutrient-rich soil. Examples of waste products from the Green Bin are food products and scraps, soil papers and sanitary napkins. Currently, Markham, like the other municipalities in the greater Toronto area, ships all of its wastes to Michigan at a cost of $22 per tone. Totonto and Ottawa are in the preliminary stages of adopting a similar programme. The city of Edmonton in Alberta, Canada has adopted large scale composting to deal its urban waste. Its composting facility is the largest of its type in the world, representing 35% of Canada centralized composting capacity (Okoroafor, 2005).

Incineration

In incineration, combustible waste is burned at temperatures high enough (900-1000^{o}C) to consume all combustible material, leaving only ash and non-combustibles to dispose of in a landfill. Under ideal conditions, incineration may reduce the volume of waste by 75% to 95%. In practice, however, the actual decrease in volume is closer to 50% because of maintenance problems as well as waste supply problems. This is approximately the same savings that could probably be realized from waste reduction and recycling. Besides reducing a large volume of combustible waste to a much smaller volume of ash, incineration has another advantage in that the process of incineration can be used to supplement other fuels and generate electrical power (Chukwurah, 1998).

Incineration and other high temperature waste treatment system are described as "thermal treatment". In effect, incineration of waste materials converts the waste into heat, gaseous emissions, and residual solid ash. Other types of thermal treatment include pyrolysis and gasification. A waste-to-energy (WtE) plant is a modern term for an incinerator that burns waste in high-efficiency furnace/boilers to produce steam and/or electricity and incorporates modern air pollution control systems and continuous emissions monitors. This type of incinerator is sometimes called an energy-from-waste (EfW) facility (Chukwurah, 1998).

Incineration is popular in countries where land is scarce because it does not consume as much area as a landfill. Japan, Sweden and Demark all practice incineration. Demark extensively uses waste-to-energy incineration in localized combined heat and facilities supporting district heating schemes. Incineration can be practiced also on a small scale by individuals and on a large scale by industries. It is recognized to be a practical method of disposing of certain hazardous waste materials, such as biological medical waste. Incineration of urban waste is not necessarily a clean process. Incineration may produce air pollution and toxic ash. For example, incineration in the United States apparently is a significant source of environmental dioxin, a carcinogenic toxin, and a controversy over incineration has resulted (Chukwurah, 1998).

Open dumps

In the past, solid waste was usually accumulated in open dumps, where the refuse was piled up without being covered or otherwise protected. Although thousands of open dumps have been closed in recent years and new open dumps are banned in the United States of America (USA) and many other countries, many are still being used worldwide. Dumps have been located wherever land is available, without regard to safety, health hazards, and aesthetic degradation.

Uchegbu (1998) posited that common sites are abandoned mines and quarries, where gravel and stone have been removed (sometimes by ancient civilizations); natural low areas, such as swamps or floodplains; and hillside areas above or below towns. The waste is often piled as high as equipment allows. In some instances, the refuse is ignited and allowed to burn. In others, the refuse is periodically leveled and compacted. As a general rule, open dumps create a nuisance by being unsightly, providing breeding grounds for pest, creating a health hazard, polluting the air, and sometimes polluting groundwater and surface water. Fortunately, open dumps are giving way to the better planned and managed sanitary landfills.

Sanitary landfills

A sanitary landfill is designed to concentrate and contain refuse without creating a nuisance or hazard to public health or safety. The idea is to confine the waste to the smallest practical area, reduce it to the smallest practical volume, and cover it with a layer of compacted soil. The layer restricts (but does not eliminate) continued access to the waste by insects, rodents, and other animals, such as seagulls. Sanitary landfill also isolates the refuse, minimizing the amount of surface water entering into and gas escaping from the waste (Pidering, 1994).

Historically, landfills were often established in discarded quarries, mining voids and burrow pit. A properly-designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials in a way that minimizes their impact on the local environment. Older, poorly-designed or poorly-managed landfills can create a number of adverse environmental impacts, such as wind-blown litter, attraction of vermin, and generation of leachate, which is the result of rain percolating through the waste and reacting with the products of decomposition. The leachate produced by chemicals and other materials in the waste can pollute ground and surface water. Another by-product of landfills is landfill gas (mostly composed of methane and carbon dioxide), which is produced as organic waste breaks down anaerobically. This gas can create odour problems, kill surface vegetation, and is a greenhouse gas (Ponniah, 1998).

Leachate

The most significant hazard from a sanitary landfill is pollution of ground or surface water. If waste buried in a landfill comes into contact with water percolating down from the surface or with groundwater moving laterally through the refuse, leachate-noxious, a mineralized liquid capable of transporting bacterial pollutants – is produced. For example, two landfills dating from the 1930s and

1940s in Long Island, New York, have produced subsurface leachate trails (plumes) several hundred metres wide that have migrated kilometers from the disposal sites (Ponniah, 1998).

Resource recovery

A relatively recent idea in waste management has been to treat the waste material as a resource to be exploited, instead of simply a challenge to be managed and disposed of. There are a number of different methods by which resources may be extracted from waste: the materials may be extracted and recycled, or the calorific content of the waste may be converted to electricity. The process of extracting resources or value from waste is variously referred to a secondary resource recovery, recycling and other terms. The practice of treating waste materials as a resource is becoming more common, especially in metropolitan areas, where space for new landfills is becoming scarcer. There is also a growing acknowledgement that simply disposing of waste materials is unsustainable in the long term, as there is a finite supply of most raw materials. In some developing countries, resource recovery takes place by way of manual labourers who wade through the waste heap to salvage materials that can be sold in the recycling market (Oluwade, 2009).

Recycling

Recycling means to recover for other uses a material that would otherwise be considered waste. The popular meaning of recycling in most developed countries has come to refer to the widespread collection and reuse of various everyday materials. They are collected and sorted into common groups, so that the raw materials from the items can be used again (recycled) (Ponniah, 1998).

Health and environmental impacts of municipal waste management (MSW)

Warren et al (2004) enumerated the health and environmental impacts of municipal solid waste as exposure to toxic chemicals through air, water and soil media; exposure to infection and biological contaminants; stress related to odour, noise, vermin and visual amenity; risk of fires, explosions, and subsidence; and spills, accidents and transport emission. Environmental impacts can be clustered into six categories: global warming, photochemical oxidant creation, abiotic resource depletion, acidification, eutrophication, and ecotoxicity to water.

Landfills are associated with a plethora of health and social effects. Health and social impacts include odour nuisance, ozone formation (from reaction of NO_x and non-methane organic compounds with sunlight) that can cause pulmonary and central nervous system damage, fire and explosion hazards from build-up of methane, an increase in the number of venmin (birds, rodents and insects) which act as disease vectors, and ground and air pollution from leachate and landfill gases. Water contamination by leachate can transmit bacteria and diseases. Typhoid fever is a common problem for the people of developing nations because many of them cannot afford to dig wells deep enough to reach fresh aquifers (Oluwade, 2009).

There are also many environmental impacts of landfills. Ozone formation can cause decreases in crop yield plant growth rate. Methane and carbon dioxide are greenhouse gases that contribute to global warming. Methane is twenty times more effective at trapping heat than carbon dioxide, and more persistent in the environment. Leachate from the landfill can enter ground water systems, leading to increases in nutrient levels that cause eutropication. Finally, bioaccumulation of toxins and heavy metals can occur.

Incineration impacts society by production of odours and in the unsightliness of the facility. There is also the potential for surface water pollution from waste waters (used for quenching hot ashes before transport). The most important health and environmental impact is from air emissions, which include particulates, carbon (II) oxide (CO), oxides of nitogen (NO_x), acid gases (chlorides and sulphides), volatile organics and mercury. These compounds contribute to bioaccumulation of toxins and acid rain. Inhalation of particulate matter poses a health danger. Smaller particulates are more likely to carry heavy metals, which can be retained in lung tissue and enter the bloodstream (Okapla, 1986).

Health and social impacts include noise, odour, and unsightliness. Actually, many of the micro-organisms found in compost are known as respiratory sensitizers that can cause a range of respiratory symptoms, including allergic rhinitis, asthma, and chronic bronchitis. Both composting and anaerobic digestions produce biogases, though less than landfills. Composting is aerobic and produces primarily carbon (IV) oxide (CO_2), while anaerobic digestion produces methane (CH_4). Both gases contribute to global warming (Okapla, 1986).

According to Uchegbu (1998), recycling can also pose health and environmental risks. Sorting facilities contain high concentrations of dust, bio aerosols and metals. Workers commonly experience itching eyes, sore throats and respiratory diseases. Environmentally speaking, recycling uses a large amount of energy resources.

Health and social side effects are equally as important as environmental impacts when considering MSW management. For people in developing countries, bodily well-being is a far more pressing concern than the fact that open burning of garbage contributes to acid rain or global warming. Outrage over health issues of poor waste management could, therefore, be a motivating factor towards more sustainable environmental practices, as suggested in Dryzek's discourse on green rationalism.

MDETHODOLOGY

Research Design

This research is basically a survey design research in that all the data used were collected with the use of questionnaire for the collection of primary data. The data sets presented here were based on the field work undertaken in Enugu in 2009. Layout maps of study area and photographs of locations of solid waste collection centres were collected and used to identify and analyse the problems involved.

The study area

Enugu State, Nigeria, has a population of about two million, while Enugu, the capital city, has a population of 722,664 (NPC, 2006). The people of Enugu belong largely to the Igbo ethnic group, which is one of the largest ethnic groups in Nigeria. The name Enugu comes from the two Igbo words *enu* and *ugwu* ("top of the hill") (Okoroafor, 2005).

Enugu was originally the capital of the Eastern Region from Nigeria's independence in 1960 until May 30, 1967, when it was declared the first capital of the short-lived nation of the Republic of Biafra. On September 28, 1967, when Enugu was captured by the Nigerian troops, the Biafran capital was moved to Umuahia (Emengini, 2004).

After the end of the Nigerian Civil War in 1970, the old Eastern Region was divided into three States, namely East Central, Cross River and Rivers. Enugu became the capital of East Central State. In 1976, the East Central State was divided into Anambra and Imo States, and Enugu remained the capital city of Anambra State. In 1991, Anambra State was split into two States, namely

Enugu State and Anambra State. Enugu retained the status of capital city of the newly-created Enugu State.

Enugu city comprises a number of layouts or neighbourhoods. They have been classified according to their population and population density levels, which are important because they characterize the nature and quantity of solid wastes generated in the city. They are the high-density neighbourhoods of Abakpa-Nike, Emene, Iva Valley, Ogui, Asata, Coal Camp, Uwani, Ogui New Layout, Obiagu, and Achara Layout; medium-density neighbourhoods of Awkunanaw, Maryland, New Haven, and Ugwu Aaron; and low-density neighbourhoods of Trans-Ekulu, Government Reservation Area (GRA), City Layout, Golf Estate, Ebeano Estate, Loma Linda, and Independence Layout (Okoye, 2008).

According to the Enugu Metropolitan Master Plan (1979), the high-density neighbourhoods commonly harbour upwards of 700 persons per hectare, about 70% of the city's population, with predominant tenement house types susceptible to low-income habitation. The average monthly household income range was ₦20,000 - ₦50,000.

The medium-density neighbouroods absorb about 28% of the entire city population with dominance of blocks of flats building type costing average monthly rent range of ₦10,000 - ₦20,000. Average density is between 350 and 400 persons per heactare. The average household of between 6 and 6.5 persons per household has been observed, with an average of 6 households per building. Their solid wastes are handled privately in the flats. One household generates an average of 10 kilograms of solid wastes daily, giving over 800 kg of solid wastes per hectare per day (Chukwurah, 1998).

The low-density neighbourhoods harbour about 2 % of the urban population and cover not less than 20% of the urban areas. They have varying low densities of 18 to 60 persons per hectare.

Dominant house types include storey building, mansions and semi-detached duplexes. There are also appreciable number of bungalows and blocks of flats in these areas. However, the composition of these building types varies in these neighbourhoods due to the fact that some of them are "less exclusive" than others (Chukwurah, 1998).

Study population

The National Population Commission (NPC) (2006) gave the 2006 census populations of some of the neighbourhoods: Abakpa (80,200), Nike (80,025), Emene (70,021), Iva Valley (70,545), Ogui (80,020), Coal Camp (70,460), Akwuke (70,010), Obiagu (80,101), Garriki (70,132), Maryland (70,132), New Haven (40,017), Awkunanaw (40,360), Achara Layout (48,012), Uwani (40,584), Trans-Ekulu (12,828), GRA (14,237), and Independence Layout (12,326).

Sampling technique

The multi-stage sampling technique was used. First, the neighbourhoods were stratified into three, according to their known populations: 61,000 and above, 41,000-59,000, and 10,000-39,000. Secondly, a neighbourhood was purposively selected from each stratum to represent it.

Stratum 1	Stratum 2	Stratum 3
Abakpa (80,200)	Achara Layout (48,012)	Trans-Ekulu (12,828)
Obiagu (80,101)	Uwani (40,584)	GRA (14,237)
Nike (80,025)	Awkunanaw (40,360)	Independence Layout (12,326)
Emene (70,021)	New Haven (40,017)	
Ogui (80,020)		
Iva Valley (70,545)		
Coal Camp (70,460)		
Garriki (70,132)		
Maryland (70,132)		
Akwuke (70,010)		

Thirdly, a systematic selection of one out of every 20 households was made in the selected high-population neighbourhood; one out of every 10 households in medium-population neighbourhood; and one out of every 5 households in the low-population neighbourhood. Thus, Coal Camp, New Haven and Independence Layout were selected for the study. Their 2006 populations are 70,460, 40,017 and 12,326 respectively, totalling 122,830.

Sample size determination

The Taro Yammane statistical formula was used. This is given as

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

Where n is desired sample population size
N is study population
e^2 is 0.05 (level of significance)

Since, the total study population for the three selected neighbourhoods was 12,830, the desired sample size, n, was calculated as follows:

$$n = \frac{122{,}830}{1 + 122{,}830(0.05)^2} = \frac{122{,}830}{308.075} = 398.7$$

Therefore, 400 was used. The number was further shared proportionately among the 3 neighbourhoods, as follows:

Coal Camp: $\frac{70{,}460}{122{,}830} \times 400 = 230$

New Haven: $\frac{40,017}{122,830} \times 400$ = 130

Independence Layout: $\frac{12,326}{122,830} \times 400$ = 40

Method of data collection

Four hundred (400) copies of structured questionnaire were distributed to the seleced neighbourhoods, as follow: Coal Camp (230), New Haven (130) and Independence Layout (30). The questionnaires were administered to volunteer or willing representatives of the selected households. Questions covered the demograph information about the respondent and the 4 research questions. Answer options were arranged in a 4-point likert-scale of Strongly Agree (SA: 4 point), Agree (A: 3 point), Disagree (D: 2 point), and Strongly Disagree (SD: 1 point).

Data analysis and test of hypotheses

The data were presented in frequency tables and simple percentage tables. The average mean score (AMS) technique was used to test the hypotheses. The AMS was obtained by taking the average of all the options (4, 3, 2, 1), as follows:

Total score = 4 + 3 + 2 + 1 = 10

Average Mean Score = $\frac{10}{4}$ = 2.5

For the collated answers and their scales from the selected neighbourhoods,

$$CV = \frac{\sum fx}{\sum f}$$

Where f is frequency
x is scale of supplied answer

A calculated value (CV) was compared with the decision value (DV).

Decision rule
If DV > CV, H_o is accepted as being true. But, if DV < C.V., H_o is rejected as untrue and the alternative hypotheses will be accepted as true.

RESULTS AND DISCUSSION

Table 1 shows the distribution of questionnaires. Four hundred (400) copies of questionnaire were distributed as follow: 230 (Coal Camp), 130 (New Haven), 40 (Independence Layout). All of them were retrieved because of instanta system of questionnaire administration.

Table 2 shows the demographic information on the respondents, covering 6 items as reflected in Tables 2.1-6. Fifty (50) or 12.5 % of respondents were of age bracket 20-24, 69 or 17.2 % of respondents were of age bracket 25-29, 144 or 36.1 % of respondents were of age bracket 30-34, 43 or 10.7 % of respondents were of age bracket 35-39, 57 or 14.2 % of respondents were of age bracket 40-44, and 37 or 9.3 % of respondents were 45 years and above. (See Table 2.1.) This shows that modal class of the ages is 30-34 years, constituting 36.1 % of the respondents. This is a healthy development because this group is a very active age group in the society.

The males were 73.3 %, while females were 26.7 % of respondents (see Table 2.2.) Those with some formal education were 87 %, while those without any formal education were 13 %. As many as 109 (or 27.3 %) and 118 (29.5 %) had tertiary and secondary education respectively (see Table 2.3). As many as 121

(30.3 %) had primary education, while 52 (13 %) had no formal education. This means respondents were enlightened members of the society, who must have understood the questions and given the answers solicited.

Traders were 43.5 % of the respondents, civil servants were 42.5 %, professionals were 5.8 %, students were 0.7 %, and non-classified respondents were 7.5 % (Table 2.4). Therefore, over 91 % of the respondents were economically independent and would not mind whose ox is gored in their offer of frank opinions solicited by the questionnaire.

The length of stay of the respondents is necessary for effective observation and knowledge of what obtains in the neighbourhood to be reflected in their answers to the questions. Those who had lived for less than a year in the neighbourhood were 7.5 %; 2-5 years were 11.2 %; 6-9 years were 37.2 %; and 10 years and above were 44.1 %. (See Table 2.5.) Thus, over 81 % of respondents had lived in the neighbourhood for 6 years upwards. This was a sufficient length of time to be aware of the goings-on in the neighbourhood. Particularly impressive is that repondents who had spent upwards of 10 years in the neighbourhood were over 44 %.

Awareness of ESWAMA and it activities came by the radio (29.8 %) to 119 respondents, by television (39.7 %) to 159 respondents, by newspapers (0 %) to no respondent, by fliers (0 %) to no respondent, by public forum (0 %) to no respondent, and through friends 30.5 % or 122 (Table 2.6). Respondents knew about ESWAMA and its activities through various means, except newspapers, fliers and public fora.

Table 3 shows the technical information from the respondents, covering the research questions as reflected in Tables 3.1-4. About 38.7 % of respondents strongly agreed that residents significantly complied with ESWAMA directive on taking refuse to the neighbourhood dudstbin, while 36.8 % agreed. Only 16.8 %

of respondents disagreed, and 7.7 strongly disagreed (Table 3.1). Thus, 75.5 % of respondents agreed, while 24.5 % disagreed. Therefore, the public significantly complied with ESWAMA directive on taking refuse to the neighbourhood dudstbin. This development could be attributed to ESWAMA court action against defaulters, as was confessed to the researcher by respondents. This is a heart-warming finding, especially as Okoroafor (2005) had observed that failure to collect 30-50 % of solid wastes generated within cities led to solid wastes accumulating to block the road and drainage channels with garbage, fire outbreak, and serious health hazard for children playing on the site.

About 37 % of respondents strongly agreed that residents significantly complied with ESWAMA directive on bagging of refuse meant for the neighbourhood dudstbin, while 40.5 % agreed. Only 14 % of respondents disagreed, and 8.5 % strongly disagreed. Thus, 77.5 % of respondents agreed, while 22.5 % disagreed (Table 3.2). Therefore, the public significantly complied with ESWAMA directive on bagging refuse meant for the neighbourhood dudstbin. This development could be attributed to ESWAMA court action against non-compliance, as was confessed to the researcher by respondents. Ekwuozor (2005) observed that the compositions of solid wastes vary and that resource recovery and recycling cannot be accomplished without the sorting of wastes into various components. Bagging wastes before taking them to public dustbin makes sorting easier before collection by waste trucks.

About 38.2 % of respondents strongly agreed that residents significantly complied with ESWAMA directive on cleaning the neighbourhood on the environmental sanitation day (usually one Saturday in a month), while 39.6 % agreed. Only 15.2 % disagreed, and 7 % of respondents strongly disagreed (Table 3.3). Thus, 77.8 % of respondents agreed, while 22.2 % disagreed. Therefore, the public significantly complied with ESWAMA directive on cleaning the neighbourhood on the environmental sanitation day. This development could be attributed to ESWAMA court action against flouting the rule, as was confessed to the researcher by respondents.

About 37.2 % of respondents strongly agreed that residents significantly complied with ESWAMA directive on payment of sanitationrate, while 40.2 % agreed. Only 15.4 % of respondents disagreed, and 7.2 % strongly disagreed (Table 3.4). Thus, 77.4 % of respondents agreed, while 22.6 % disagreed. Therefore, the public significantly complied with ESWAMA directive on payment of sanitation rate. This development could be attributed to ESWAMA court action against defaulters, as was confessed to the researcher by respondents.

Hypotheses testing

The CVs for null hypotheses for the 4 objectives were 3.04, 3.07, 3.10, and 3.14 respectively (Table 4). The DV (2.5) was greater than each of the CVs. Therefore, all the null hypotheses were rejected as untrue, and the alternative hypotheses were accepted as true. Therefore, the public compliance with ESWAMA directive on taking wastes to neighbourhood dustbin, bagging of waste meant for neighbourhood dustbin, cleaning the neigbourhood on the environmental sanitation day (usually one Saturday in a month), and payment of sanitation rates was significant.

SUMMARY OF FINDINGS AND CONCLUSION

Public particpation in environmental waste disposal in Enugu city has been investigated. There is significant compliance of the residents of Enugu with ESWAMA directives on on taking wastes to neighbourhood dustbin, bagging of waste meant for neighbourhood dustbin, cleaning the neigbourhood on the environmental sanitation day (usually one Saturdy in a month), and payment of sanitation rates.

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APPENDIX

TABLES

Table 1 ***Questionnaire distribution***

Selected neighbourhood	**No. administered**	**No. returned**
Coal Camp (HD)	230	230
New Haven (MD)	130	130
Independence Layout (LD)	40	40
Total	**400**	**400**

Table 2.1: ***Distribution of respondents by age***

Age	**No. of respondents**	**Percentage**
20 – 24	50	12.5
25 – 29	69	17.2
30 – 34	144	36.1
35 – 39	43	10.7
40 – 44	57	14.2
45 +	37	9.3
Total	**400**	**100**

Table 2.2: ***Distribution of respondents by sex***

Age	**No. of respondents**	**Percentage**
Male	293	73.3
Female	107	26.7
Total	**400**	**100**

Table 2.3: ***Respondents distribution by educational levels***

Highest educational level attained	**No. of respondents**	**Percentage**
No formal education	52	13.0
Primary education	121	30.3
Secondary education	118	29.5
Tertiary education	109	27.2
Total	**400**	**100**

Table 2.4: ***Distribution of respondents by occupation***

Occupation	**No. of respondents**	**Percentage**
Civil servant	170	42.5
Trader	174	43.5
Student	3	0.7
Professional	23	5.8
Others	30	7.5
Total	**400**	**100**

Table 2.5: ***Distribution of repondents by length of stay in the neighbourhood***

Length of stay	**No. of respondents**	**Percentage**
< 1 year	30	7.5
2 – 5 years	45	11.2
6 – 9 years	149	37.2
10 + years	176	44.1
Total	**400**	**100**

Table 2.6: ***Sources of awareness of ESWAMA and its activities***

Source	**No. of repondents**	**Percentage**
Radio	159	39.7
Television	119	29.8
Newspapers	0	0
Fliers	0	0
Public forum	0	0
Friends	122	30.5
Total	**400**	**100**

Table 3.1: ***Public compliance with ESWAMA directive on taking wastes to neighbourhood dustbin***

Response	Scale, x	Frequency, f	fx	Percentage
SA	4	155	620	38.7
A	3	147	441	36.8
D	2	67	134	16.8
SD	1	31	31	7.7
Total		**400**	**1,226**	**100**

$$CV = \frac{\sum fx}{\sum f} = \frac{1,226}{400} = 3.04$$

Table 3.2: ***Public compliance with ESWAMA directive on bagging of waste meant for neighbourhood dustbin***

Response	Scale, x	Frequency, f	fx	Percentage
SA	4	148	592	37
A	3	163	489	40.5
D	2	56	112	14
SD	1	34	34	8.5
Total		**600**	**1,227**	**100**

$$CV = \frac{\sum fx}{\sum f} = \frac{1,227}{400} = 3.07$$

Table 3.3: ***Public compliance with ESWAMA directive on cleaning the neigbourhood on the environmental sanitation day (usually one Saturdy in a month)***

Response	Scale, x	Frequency, f	fx	Percentage
SA	4	153	612	38.2
A	3	159	477	39.6
D	2	61	122	15.2
SD	1	28	28	7
Total		**600**	**1,239**	**100**

$$CV = \frac{\sum fx}{\sum f} = \frac{1,239}{400} = 3.10$$

Table 3.4: ***Public compliance with ESWAMA directive on payment of sanitation rates***

Response	Scale, x	Frequency, f	fx	Percentage
SA	4	149	596	37.2
A	3	161	483	40.2
D	2	62	186	15.4
SD	1	29	29	7.2
Total		**400**	**1,294**	**100**

$$CV = \frac{\sum fx}{\sum f} = \frac{1,294}{400} = 3.24$$

Table 4: ***Asseessed aspect of public participation, null hypotheses, CVs and decisions***

Aspect of participation assessed	Null hypothesis	CV	Decision
Taking wastes to neighbourhood dustbins.	Residents of Enugu city do not comply significantly with ESWAMA directive on taking wastes to neighbourhood dustbins.	2.04	Reject n.h.
Bagging the wastes meant for neighbourhood dustbins.	Residents of Enugu city do not comply significantly with ESWAMA directive on bagging the wastes meant for neighbourhood dustbins.	3.07	Reject n.h.
Cleaning the neighbourhood on environmental sanitation days (usually one Saturdy in a month).	Residents of Enugu city do not comply significantly with ESWAMA directive on cleaning the neighbourhood on environmental sanitation days (usually one Saturdy in a month).	3.10	Reject n.h.
Payment of sanitation rate.	Residents of Enugu city do not comply significantly with ESWAMA directive on payment of sanitation rate.	3.24	Reject n.h.