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Characterization of Municipal Solid Waste in Yenagoa Metropolis and Its Associated Management Problems, Nigeria

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Abstract: ***Waste proliferation has increasingly become a serious concern of municipal authorities in recent times, especially for developing countries and municipalities. This paper presents the composition of municipal solid wastes generated in the Yenagoa metropolis and dumped in the Yenagoa Central waste dumpsite, Bayelsa State Nigeria. The character of the municipal solid waste was determined in terms of the composition of individual waste in the waste stream using average mass (kg) and percentage composition by mass of the various components using electronic weighing balance. It was found that 53.125% of the solid waste generated in the study area was made up of organic waste. Out of this percentage, food waste was the most abundant with 32.38% by mass. Vegetable waste recorded 5.8% composition by mass. Paper and Textile recorded 6.5% and 6.38% respectively. Wood waste had 2.13% composition by mass. While the percentage of inorganic waste within the waste stream was 46.875% in the following order, Plastic and nylon bags recorded 20.38% by mass of the total waste stream. Bottles, leathers, ceramics and construction wastes recorded 8%, 1.38%, 1.13% and 5.63% respectively. Electronic waste recorded 6.75% composition by mass. Metals, Cans and Battery wastes recorded 0.75%, 2% and 0.25% respectively. Finally, medical waste recorded 0.63% composition by mass. It is recommended that adequate financial provision, proper waste legislation, training and re-training of staff and full community participation in waste management should be encourage. Formal composting and recycling facilities should also be setup to enhance adequate management of waste.***
Keywords: Municipal Solid Waste, Characterization, Proliferation, Composition.

I. INTRODUCTION

The proliferation of waste in the environment, occasioned by its inadequate management by residents and authorities has posed a growing concern in developed and developing nations. Since waste is generated by all humans and at all times, population explosion and the humans' continues crave for a better life have increased the complexity of waste over the years. Municipal solid waste (MSW) disposal has therefore become a global concern across the world, as poverty, population growth, high urbanization rates and industrialization combined with ineffectual and under-funded government policies to present efficient management of wastes (Cointreau, 1982; Doan, 1998). Out of the numerous methods of waste management, Landfilling is seemingly the preferred and most adopted method. This is as a result of it being the simplest, cheapest and most cost effective method of disposing of waste in both developed and developing nations of the world (Barrett and Lawlor, 1995), but it is not without its negative consequences.

Like many other developing nations, Nigeria faces many solid waste management (SWM) challenges ranging from inadequate collection coverage, improper methods of transportation, poor practice of final disposal, such as open dumping and burning without due regards to protection of environmental pollution, weak institutional and regulatory provisions, and lack of adequate funding (Imam *et al.,* 2008). These challenges obstruct development of effective and sustainable waste management strategies which have negatively influenced environmental components like soil, air and water quality etc.

Literature reports indicated that Nigerian average municipal solid waste density ranges from 280-370 kgm^{-3}, and the daily waste production rate is approximately 0.44-0.66 kg/capital/day (Ogwueleka, 2009), with a yearly production of 25 million tons of waste (Tariwari, *et al*., 2017). In addition, as recorded in literature, Nigerian municipalities have registered an outstanding population increase mainly due to rural-urban migration (Adejobi, 2012), this is largely motivated by the quest for a better life and the crave for getting closer to modern civilization.

The solid content in a municipal waste is technically known as refuse while the liquid substances are called effluent (Ahmed, 2002). According to Environmental Protection Department Air Management Group, EPDA (2001), waste involves categories of household, municipal, commercial and industrial wastes, some hazardous and toxic. Municipal solid waste includes wastes generated from residential, commercial, industrial, institutional, construction, demolition wastes.

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Household or residential wastes are generally food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes. Commercial Stores, hotels, restaurants, markets generate paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, etc (Tchobanoglous *et al.,* 1993). In order to implement a proper waste management system within a municipality, the waste must be characterized for compositional evaluation. Waste characterization is a fundamental component in any municipal waste management system (MWMS) of urban solid waste in a city but such data are not commonly compiled in cities across Africa (Guadalupe *et al,* 2009).

Waste characterization therefore consists of information on the types and amounts of waste materials (paper, food waste, glass, yard waste, etc.) present in a waste stream. It depends on a number of factors such as food habits, cultural tradition, socioeconomic and climatic conditions. It varies not only from city to city but even within the same city itself (Gawaikar, 2004).

The composition and characteristics of municipal solid waste is influenced by certain factors, which include the area (residential, commercial, etc), the economic level (differences between high and low income areas), the season and weather (differences in the amount of population during the year, tourist places) and culture of people living or doing business in the area. High-income and advanced societies usually produce more inorganic materials such as plastics and paper, while low-income and developing societies produce relatively more of organic waste. Uncontrolled or improperly sited open solid waste dumpsites constitute health hazards and damage the aesthetic beauty of many cities in Nigeria (Napoleon *et al.,* 2011). Characterization of municipal solid wastes is simply a descriptive means of identifying the various constituent of the waste stream in terms of quantity and quality generation taking into account location as well as seasons in which these wastes are generated. It is a means of finding out how much paper, glass, food waste, etc. is discarded in the municipal waste stream. According to Gawaikar (2004), characterization of municipal solid waste helps in determining the quantity of waste generated in a particular location at a particular time of the year. Characterization of municipal solid wastes is simply a descriptive means of identifying the various constituents of the waste stream in terms of quantity and quality generation taking into account location as well as seasons in which these wastes are generated, and equipment required for proper waste management, the needed resources for the protection of environment and public health. However, unlike developed nations, data on characterized waste within the Nigerian context is hard to come by for proper planning and implementation of a holistic waste management strategy. Municipal waste characterization can be of either physical/manual or chemical/laboratory methods to ascertain what the waste is actually made of. In this study however, the former is applied to evaluate the character of waste within the dumpsite. Among the many other ways of waste treatment, landfills have served for many decades as ultimate disposal sites for all types of wastes (Abu-Rukah and Al- Kofahi, 2001).

II. METHODOLOGY

A. Study Area

The study was carried out at the official waste dump approved by the Bayelsa State government, the Yenagoa central waste dumpsite. The study area is Yenagoa Local Government Area (LGA) of Bayelsa State, Nigeria. Yenagoa LGA is geographically located within latitudes 4°49'N and 5°23'N and also within longitudes 6°10' E and 6°33' E (Koinyan *et al.,* 2013). Yenagoa City doubles both as the capital of Bayelsa State as well as the headquarters of Yenagoa Local Government Area of Bayelsa State**.** Figure 1 shows a modified google map of the study area, indicating the dump site in red circle, while Figure 2 is a pictorial view of the dumpsite.



Figure 1.0: Satellite Image of the Study Area Showing the Waste Dumpsite
(Google map: Modified by Author)

The dumpsite services Yenagoa city and environs, it is located at Abanigi road, Etelebu in Yenagoa Local Government Area of Bayelsa State, which is an offshoot of the Amassoma - Tombia road. This dumpsite serves as the central waste dumptsite within the Yenagoa metropolis. The dumpsite lies at latitude $4^0$59'28.44276" North and longitude 6019'40.47568" East respectively. The SWD site mainly accommodates residential wastes, market waste, institutional wastes, sewage from disposal companies, wastes from animal slaughter houses and information technology (IT) industries. It is in fact the final resting place for more than 95% of all the wastes generated across the growing city.



Figure 2.0: An Image Showing a View of Yenagoa Central Waste Dump
(Picture: Author's reconnaissance photograph)

B. Data Collection

1) *Characterization of Municipal Solid Waste Composition:* On-the-spot sampling method used by Nta *et al.,* (2020) was adopted in this analysis. Wastes were manually and randomly collected from delivery trucks that were disposing at the dumpsite. The unloaded waste formed a small heap, from which a ten kilogram (10kg) representative portion was taken and components identified, sorted and weighed during waste characterization. A total of eight (8) trucks were sampled, making it a total of 80kg of waste sampled throughout the research. The 80Kg of waste sampled was sorted into various components and each component measured with weighing scale and recorded. The data obtained were expressed as percentage composition by mass was analyzed using descriptive statistics (charts and percentages).
2) *Waste Management within the Yenagoa Municipality:* As a growing city faced with its own peculiar challenges, Yenagoa city struggles to manage the waste volume generated by its residents. To evaluate the effectiveness of waste management, a scheduled interview was conducted with the help of a structured questionnaire. The interview was conducted with the Director, waste management at the Bayelsa State Environmental Sanitation Authority (BSESA). At the interview session, salient questions about the general challenges faced by the waste management sector of the State and results taken.

III. RESULTS AND DISCUSSION

A. Reconnaissance

The observations made on the dumpsite were as follows;

1) The dumpsite was at all times divided into two parts. One part was active, while the other inactive part was set on fire to reduce the waste volume.
2) A nauseating odor coming from the dumpsite was strong and could be perceived even at long distances.
3) A large number of scavengers from the informal sector collecting recyclable waste from the dumpsite were present and picking what they needed.
4) There were recycling dealers from the informal sector within the dump site who bought the recyclable materials from scavengers.
5) The dumpsite had no fence, no weigh bridge.
6) Waste disposal trucks were moving waste from the municipality to the dumpsite.
7) Complaints from the nearby residents were mainly of odour and pests.
8) A large number of pests (pigs, flies, birds, rodents, mosquitoes and cockroaches) were observed.

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Figure 3.0: A pictorial view of Pest spotted at the Yenagoa Central Waste Dump

B. Composition of Municipal Solid Waste

Table 1.0 shows the various constituents and percentage composition by mass of the waste stream within the Yenagoa metropolis. In this study, 15 components were identified in the collected waste samples. Organic waste component which were five (5) constituted a total mass of 42.5kg making up 53.13% by mass of the total waste, while the inorganic waste constituents which were ten (10) constituted a total mass of 37.5kg making up a portion of 46.87% by mass. Figure 4.0 below shows the distribution of waste according to organic and inorganic components.

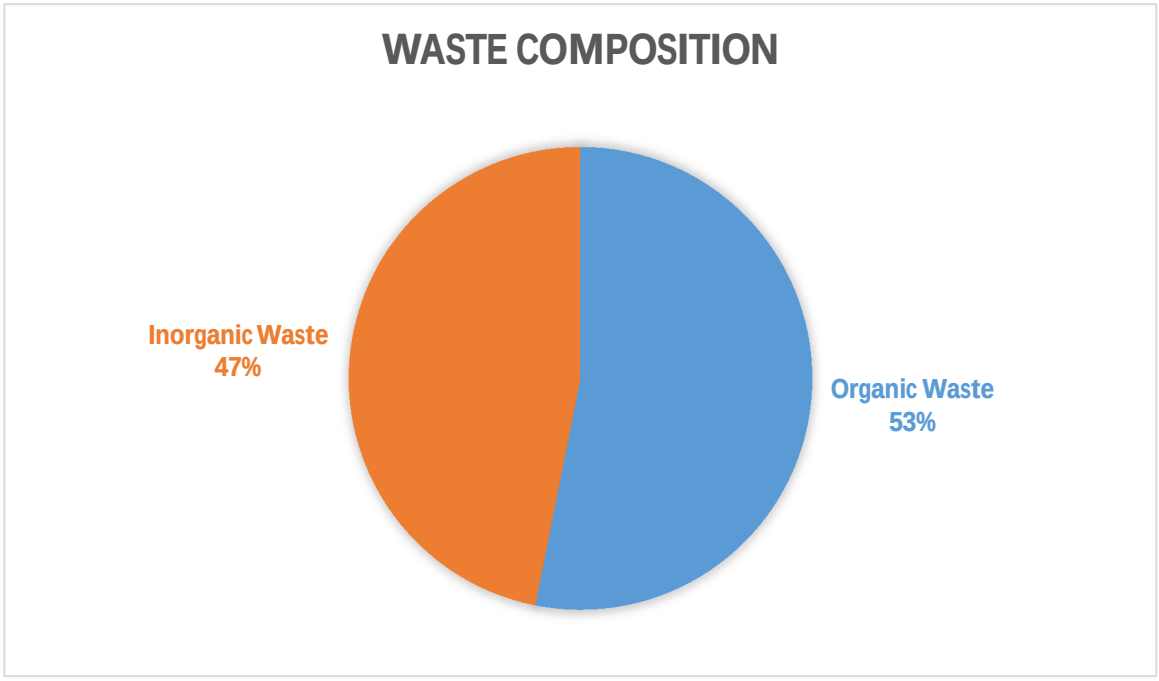


Figure 4.0: A Pie-chat Representing the Organic and Inorganic Components of Yenagoa Municipal Waste

From the results of Table 1.0 below showed the distribution of the various components of waste generated within the municipality.

Table 1.0: Composition of Municipal Solid Waste (Yenagoa Central Waste Dump)

Constituents	Mass (Kg)	Percentage (%) Composition by mass
Organic waste		
Garbage (food) waste	25.9	32.375
Vegetables	4.6	5.75
Paper	5.2	6.5
Textiles	5.1	6.375
Wood	1.7	2.125
Total	42.5	53.125
Inorganic waste		
Electronic waste	5.4	6.75
Cans	1.6	2
Plastic bags/Nylon bags	16.3	20.375
Bottles	6.4	8
Leathers	1.1	1.375
Ceramics	0.9	1.125
Construction material	4.5	5.625
Metals	0.6	0.75
Battery	0.2	0.25
Medical waste	0.5	0.625
Total	37.5	46.875
Net Total	80	100

Source: Author's fieldwork 2019

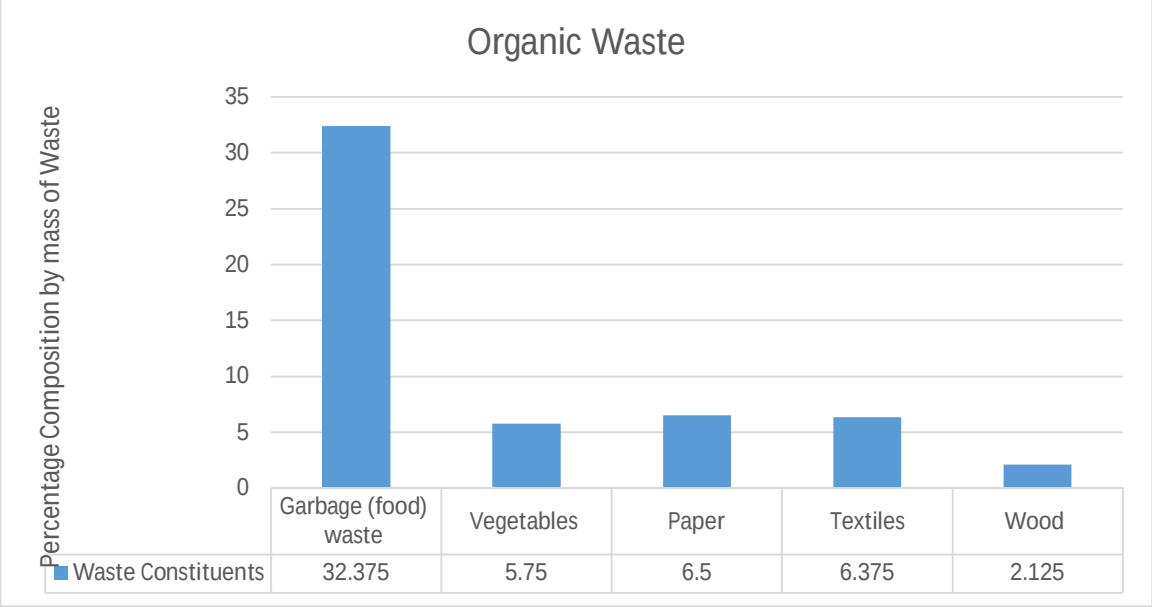


Figure 5.0: Organic Waste Distribution within Yenagoa Municipal Waste Stream

Figure 5.0 showed that food waste had the highest percentage (32.38%) by mass, thus making it most abundant in the waste stream. Vegetable waste recorded 5.8% composition by mass which is agricultural waste. Paper and Textile recorded 6.5% and 6.38% respectively. Wood waste had 2.13% composition by mass.

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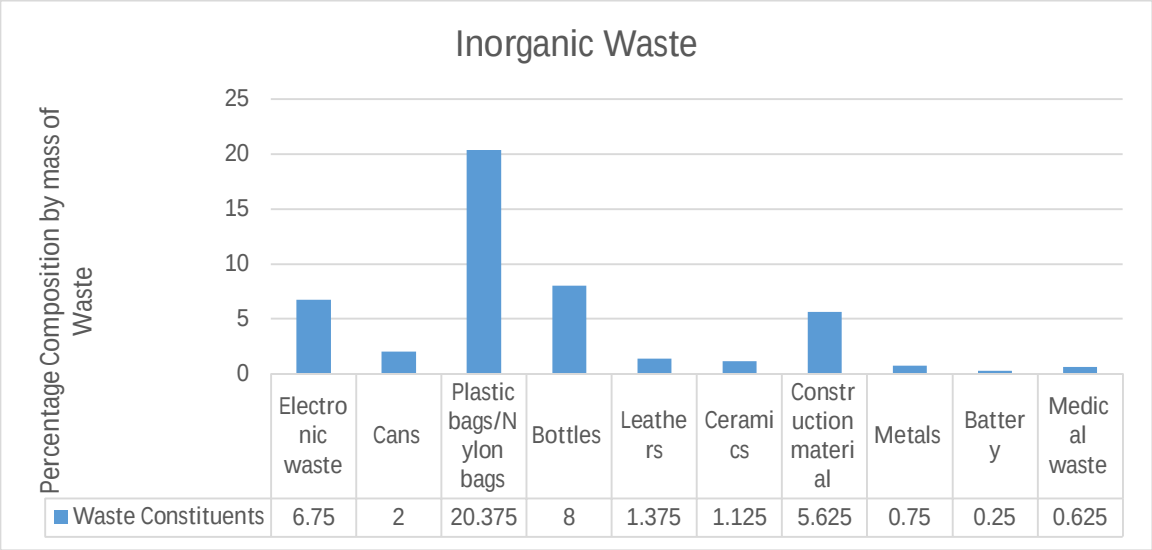


Figure 6.0: Inorganic Waste Distribution within Yenagoa Municipal Waste Stream

Figure 6.0 showed that plastic and nylon bags recorded 20.38% by mass of the total waste stream. The percentage of plastic waste increased with an increasing percentage of garbage waste since they were mainly used for packaging goods. Bottles, leathers, ceramics and construction wastes recorded 8, 1.38, 1.13 and 5.63% respectively. Electronic waste recorded 6.75% composition by mass. Electronic waste thus even though the percentage by mass of this waste is small, toxicity potential can cause a very significant environmental problem. Metals, Cans and Battery wastes recorded 0.75, 2 and 0.25% respectively. Finally, medical waste recorded 0.63% composition by mass.

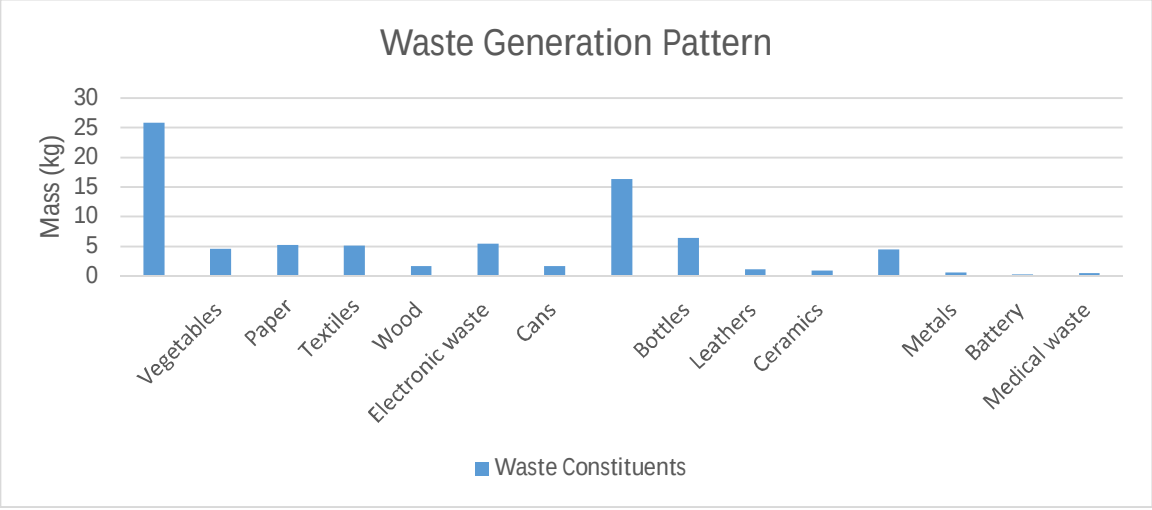


Figure 7.0: Waste Composition within Yenagoa Municipal Waste Stream

The results in Figure 7.0 indicated that food waste was mainly what constituted the waste load in the landfill, this may contribute to a high amount of total coliform in the leachate samples within the dumpsite. Plastic bags/ nylon showed a remarkable presence in the waste stream because of its usefulness in terms of packaging, reflecting the average life style of the residents. Paper waste showed a remarkably low volume largely because of the lack of institutions that use paper regularly. Batteries, metals and cans found within the waste load were very minimal. This may have been as a result of the lack of the required industries as well as the activities of scavengers (rag pickers) operating from the informal recycling sector. Batteries, metals and cans were seen to be of minimal presence. The results from the interview suggested that the environmental situation within the study area is faced with challenges of solid waste management (SWM) which has threatened the environment. There is only one official solid waste disposal site that serves the Yenagoa metropolis, the other numerous unofficial/unapproved solid waste dump (SWD) locations within the city are all poorly situated in a rudimentary and haphazard manner with little or no regard for environmental sustainability.

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Waste disposal activities in the official site has also resulted to a gross interference of pollutants with the water quality, largely because of poor management strategies. The criteria for siting of SWD sites in Yenagoa was evaluated with respect to a thorough environmental assessment, relative to human settlements, water supply sources and other environmental characteristics. It was observed that no proper EIA was conducted for the siting of dump sites. Availability of land championed most of the decisions to dump site location within the Yenagoa metropolis. The disposal site was observed to be in close proximity to residential areas as well as interfering with a major road linking towns (Ogboloma, Nedugo-agbia, Okolobiri etc) to the city center, thereby condemning the road and cutting-off these towns' potential for accelerated development. This singular act denies the people of this region from possible development, which is in sharp contrast to any sound environmental management practice.

SWM in the metropolis was confirmed as not properly organized, inefficient and highly compromised as a result of inadequate funding, weak regulatory and operational frameworks, poor public awareness and participation, poor legislations, poor government involvement as well as a serious lack of technical and technological skills. The practice is, therefore, not sustainable and poses a significant threat to the environment, especially surface and groundwater resources and public health. Therefore, SWM in the area must be improved, in order to achieve the desired goal of sustainable development in the region.

IV. CONCLUSION

Like many developing cities, the findings in this study indicated that organic waste accounted for a larger percentage of the waste generated in Yenagoa metropolis. Organic components including food/garbage waste, vegetable, paper, textiles and wood contributed 53.13% by mass, while the inorganic components were Electronic, Cans, Plastic bags/nylon, plastics/rubbers, Construction Material, Metals, Medical waste and others constituted 46.875% by mass. This is in conformity with most of the waste generated in growing countries. Results also revealed that the volume of Metal, Can, Batteries were very minimal in the waste stream indicating a minimal production and use of such materials within the study area, as a result of lack of appropriate industries. Because of the increased volume of organic waste, pests such as rats, flies, mosquitoes, birds, pigs and cockroaches were observed to be present at the dumpsite, which are potential carriers of vector-borne diseases associated with municipal solid waste.

It is therefore recommended that a compressive solid waste management program that includes stakeholders' involvement, disposal policies formulation, waste reduction and recycling project be put in place such that impact on soil, surface and groundwater qualities, and indeed the health of the nearby communities will be as low as reasonably possible. There is need for adequate budgetary provision for Bayelsa State Environmental Sanitation Authority (BSESA) for proper training and replacement of the existing vehicles with modern equipment to reduce operating costs. The agency should also encourage community participation and involvement in waste management. Also formal composting and recycling facilities should be setup at Yenagoa Central Waste dumpsite.

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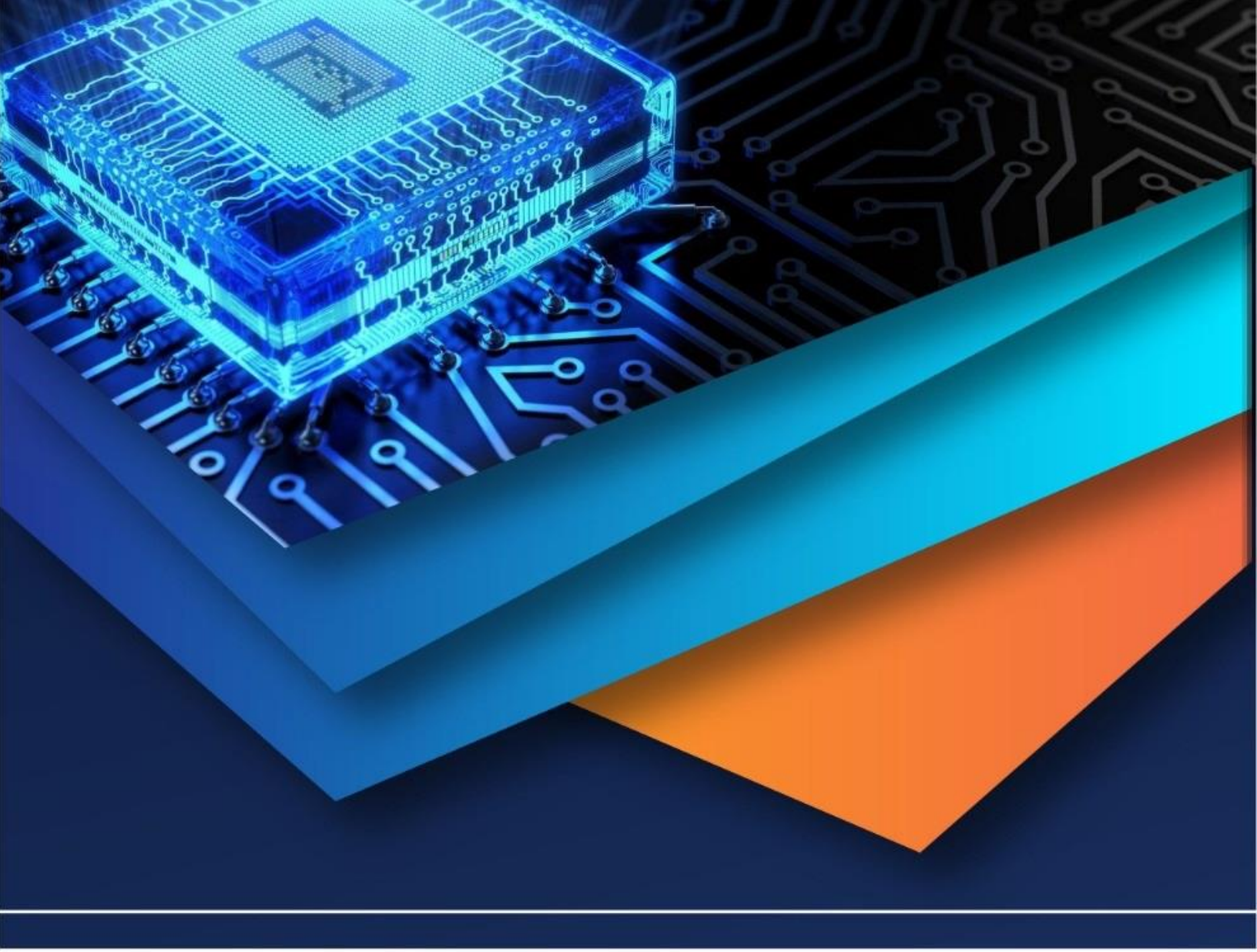
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