EQA - International Journal of Environmental Quality
ISSN 2281-4485 - Vol. 55 (2023): 12-22
Journal homepage: https://eqa.unibo.it/

published by

Solid Waste Management practices among industries in Ota, Ogun State, Nigeria

Temiloluwa E. Makinde*, Adewumi I. Badiora, Oluwasola T. Omotoso

Faculty of Engineering and Environmental Studies, Olabisi Onabanjo University, Ago-Iwoye, Ibogun Campus, Ogun State, Nigeria.

*Corresponding author E-mail: makindetemiloluwa2@gmail.com

Article info
Received 10/2/2023; received in revised form 28/4/2023; accepted 15/5/2023
DOI: 10.6092/issn.2281-4485/16445

Abstract
This study examined the profile of industries in Ota, Ogun State; determined the types of waste produced in the industries; identified and assessed the agencies responsible for managing industrial waste; examined the different storage and disposal methods employed and assessed how environmentally friendly the storage; collection and disposal methods of wastes in the industries. These were intended to provide information that will assist policymakers and industries management to develop an environmentally friendly waste management practice in the study area. Total enumeration was used in the collection of primary data from industries. A total of 102 questionnaires (80.9%) were retrieved and used for data analysis. The study established that 66.8% of the industries were manufacturing industries being the most abundant while 1% was the service industry. Also, the largest amount of waste generated in the study area was metal/steel. Next to it were paper and nylon. Findings further revealed that the most commonly used method of waste collection was big waste bags (40%) and the least being garbage bags and old metal containers (12%). In addition, 27% of the industries practiced the recycling method of waste disposal while 9.1% and 2.1% still dispose of their waste in vacant plots/open spaces and dilapidated/uncompleted buildings. The study concluded that the solid waste management practices among industries in Ota; Ogun State were not adequate thereby causing diverse impacts that are detrimental to the ecosystem.

Keywords
Solid Waste Management; Industries, Environmental Hazard, Nigeria

Introduction

Industrialization plays a pivotal role in the economic development of every nation. It serves as a measure of evaluating economic strength. As the historical record shows, the developed countries of the world broke the vicious cycle of poverty by industrializing, rather than focusing on agriculture or the production of national resources (The Arena Group, 2022). Its varied activities in terms of manufacturing, production, and even services have been of high benefit to economic development but at the receiving end posing detrimental issues to environmental quality in form of various types of waste pollution. Therefore, waste can be said tobe a major problem associated with rapid industrialization, urbanization, and the rise in the living standard of people (Ayala, 2011). Waste seems to be a by-product of growth and development.

Industrial growth has been a major propellant of environmental pollution with severe downside problems. It causes tremendous stress on the entire bio network and natural system components like water, air, soil, bio-diversity including the surrounding ecosystem (Rasmi, 2018). This gives prejudice to why Hu et al. (2021) asserted that bottom ash from metals contains unfavourable contaminants that could leach into

DOI: 10.6092/issn.2281-4485/16445

circulating water and its improper disposal could foster ecological pollution.

Nigeria has witnessed rapid urban growth, increased economic and technological development in the past few years and these have also brought about increasing industrial development coupled with various forms of environmental pollution (Momodu et al., 2011). Since the production of wastes is a fundamental part of industrial activities, it is evident, therefore, that industrial growth brings about an increase in the production of industrial wastes. These wastes are produced in the form of solids, liquids, gasses, and air-borne particulate matter, which are constantly emitted into the environment. In 2018, 351 million tonnes of plastic waste were produced worldwide (PlasticsEurope,2019). 79% of this waste was either dumped in landfills or lost to the environment (Geyer et al.,2017).

This issue has become one of the most crucial matters confronting society in general and industries in particular. Generally, concern on these issues has been a top knot constantly discussed daily through the media, such as the newspapers, internet, television, and radio. Therefore proper sorting of waste is an important aspect of waste management. The aforementioned issues have become one of the most crucial matters confronting society ingeneral and industries in particular. Advocates of environmental protection have drawn the attention of national policymakers to the health hazards and potential dangers to natural resources caused by the inadequate management of wastes (Anand, 1999; Schwarz et al., 2021) asserted that a large aspect of environmental impact is caused by high energy use and particulate matter formation. Trash bins are often used for separation at the source which calls for appropriate trash bin designs to improve waste collection and separation performance (Nattapon et al., 2021). The key hazardous waste sources include industrial, medical, and household wastes, and occur in solid, liquid, or gaseous states. Hazardous waste management practice in Nigeria is not in consonance with the best global practices. Many hazardous wastes are dumped indiscriminately, which constitutes a hazard to the environment and poses public health concerns. (Aminu and Ahmed, 2021). He further buttresses that according to the United States Environmental Protection Agency, hazardous waste generated by particular industrial processesis classified on K-List. Examples include chemical production, pesticide production, explosive manufacturing, etc. This pressing issue Adekoya (1992) submitted is posing health hazards to the residents causing diseases such as bronchitis and cancer. This gives prejudice to why Hu et al. (2021) asserted that bottom ash from metals contains unfavourable contaminants that could leach into circulating water and its improper disposal could foster ecological pollution which is often attributed to industrial waste.

More importantly, Ogun State has witnessed rapid urbanization and an increased level of industrialization over the years due to its proximity to Lagos state which is the commercial hub of Nigeria, particularly in areas around the borders like Agbara, Mowe, and Ota the study area in this study. Ota in Ado-Odo Local Government Area of Ogun State is the second-largest in Ogun State and shares boundaries with Yewa South and Ipokia Local Government areas of Ogun State and Ifako-Ijaye, Alimosho, Ojo and, Badagry Local Government areas of Lagos State. It is located within the tropical zone and lies between latitude 6.6927° N of the equator and longitude 3.2365° E of the Greenwich meridian. It covers an area of 1,263 square Kilometers with about 1,010.4 square kilometers of land terrain and 16% riverine while 4% hilly regions of the remaining land (First Economic Summit Ado Odo Local Govt., 2010). The study area has five political wards. In 2006 according to the National Population Census, the estimated population was 527,242 with a predominant Yoruba ethnicity but has over time accommodated migrants from different parts of neighboring states and even international personalities. Some of the settlement areas in Ado-Odo Ota include; Iju-Ota, Sango-Ota, Itele, Owode, Ijoko among others. There are two functional private universities - the Covenant University and the Bells University of Technology and Gateway Polytechnic at Igbesa. Numerous industrial activities abound in the area. Companies operating there include VeeVee Company, Coca-Cola Nigeria Ltd, May, and Baker Nigeria Plc., Glaxo-SmithKline Plc. among many others. Today it can be singled out as a significant industrial area in the state. Based on the aforementioned, the waste generated particularly from industries within the state has been so devastating to both the environment quality, thus defacing the environmental aesthetics and endangering human health.

Literature Review and Theoretical Framework

Industrial waste management is a staid environmental problem that has been the subject of several studies, conferences, strategic meetings, and debates.

DOI: 10.6092/issn.2281-4485/16445

Industrialization has brought lots of advantages and disadvantages as well. One of the negative impacts of industrialization is the creation of wastes. Industrial waste can be solid, gas, or liquid and each type has different methods of management and disposal (Awuchi and Hannington et. al 2020). Mohammad et al., (2015) observed that Iran generated a large number of chemicals and plastics. Private sectors were only responsible for (45%) of generated waste while the majority of wastes were buried (62%), and only (17%) of industrial waste was recycled. Onipede and Bolaji (2004) stated that the larger proportion of industrial waste pollutants are suspended solids and dissolved solids with paper being by far the most abundant of these wastes, followed by plastic, metal, glass, and wood in that order. It further revealed that most industries in Nigeria place little emphasis on proper waste management, preferring the cheapest methods of waste disposal to the most appropriate methods. Nattapon et al. (2021) in a study of the effects of colour preference and noticeability of trash bins on waste collection performance and waste sorting behavior, preferences were given to colour of waste, setting location and perceived ease in finding a trash bin.it was observed that colour preferences have no significant impact on waste collection and lower colour preferences are a key factor in the noticeability of trash bins.

Therefore colour preference is a cogent factor to be considered in ensuring that industrial wastesare properly sorted to prevent hazardous events.

Furthermore, Oladeyede et al., (2014) in their study of the visibility of solid waste recycling programs reiterated that due to prolonged years of unemployment, many people resorted to recyclable solid waste collection and selling of same for survival, encouraging the establishment of cooperative societies among the various groups of waste collectors, buyers, and users thereby creating stable employment and engaging a good number of the unemployed youth. Ochuko (2014) study on municipal waste disposal practices in Abeokuta Ogun State was apointer to the methods used of waste disposal in the state revealing open dumping (57.9%), burning of wastes (32.9%), and dumping in drainages to be (9.2%). The severity of this waste management has gone beyond simple to an issue of global deliberation thereby incorporating it in the Millenium Development Goals in 2000, and Sustainable Development Goals in 2015 among other policies. Despite all these, indiscriminately disposed wastes continue to define the physical environment of many countries around the globe, most especially, developing countries (Justice, 2021).

Methods of solid waste management

The methods of solid waste management are diverse and these methods are essential for ensuring environmental sanctity. Therefore the need for individual, corporate organizations and essentially industries to prioritize proper waste management strategies. The following are common methods of solid waste management:

Reduce, Reuse, and Recycle. Reduce is the reduction of wastes at the point of generation or before final disposal (Chadar and Chadar, 2017). Reuse 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 (Collins et al., 2021). Recycling means reusing some components of the waste that may have some economic value. When wastes are recycled or treated, they become valuable resources rather than wastes (Collins et al., 2021). Recycling conserves resources, reduce the energy used during manufacture and also reduce pollution (Chadar and Chadar, 2017).

Sanitary Landfill. This is the most common solid waste disposal method used today. Garbage is mainly spread out in thin layers, compacted or compressed and covered with plastic foam or soil. Modern landfills are designed in a way the landfill bottom is covered with impervious linerwhich is often made of many layers of thick plastics and sand (Rinkesh, 2018). Environmental effects of sanitary landfill are production of Landfill Gases (LFGs), lichates and leaving heavy metals (Pathak et al., 2011).

Composting. Composting is the regulated decomposition of organic matter to produce a final product called compost (Atalla et al., 2011). It is also the is a decomposition process that involves the biological conversion of mixed wastes into humus-like substances, by mixed microbial population (Collins et al., 2021). It requires a moisture content ranging from 40–60% and a carbon to nitrogen ratio of about of 25–30:1 (Pathak et al., 2011). It is a process or a strategy employed in the recovery or transformation of mostly organic wastes for other very useful applications (Pathak et al., 2011). Quality environmentally friendly manure

DOI: 10.6092/issn.2281-4485/16445

is made from the compost and is used for agricultural purposes. Composting is a good green method of waste management.

Pyrolysis. Is a method of solid waste management where solid wastes are chemically decomposed through heating without presence of oxygen. Pyrolysis usually takes place under pressure and at temperatures of about 430°C (Awuchi et al., 2020). The solid waste is converted into gases, small amounts of liquid, and solid residue. This process leads to the production of recyclable products like oil/wax, char and gaseous products also known as combustible gases (Czajczy´Nskaa et al., 2017). The technique is presently generating great attention globally because of this flexibility factor (Chen et al., 2014).

Incineration. Incinerations refers to high temperature combustion of waste in a high efficiency furnace to produce staem and ash (EPA,1995). Incineration of solid wastes involves burning of them at high temperatures until the waste materials turn into ashes. Incinerators are made in a way that they do not generate extreme heat when burning solid wastes and is carried out in a controlled environment called incineration facility (Chadar and Chadar. 2017). As a method of solid waste management, incineration can be done by industries, municipalities, individuals, and (or) institutions (Rinkesh, 2018).

Research Methodology: Data Collection and Analysis

The sources of data that were used in the study are primary and secondary data. The primary data was obtained directly from the field through various survey instruments such as questionnaires, interviews, pictures, and personal observation and analysis were carried out through tables by the author's survey 2019. In this study the population, frame, and size are the same, thus this research work employed total enumeration. The total population of one hundred and twenty-six (126) industries in the study area was compiled from the Manufacturers Association of Nigeria (MAN) which is 100% of the population (Table 3) were all sampled to jettison every form of bias. The secondary data in this study are the information that has previously been gathered from official and non-official documents; list of industries obtained from the Nigeria Industrial Directory. Also, the location maps of the study were obtained through Google Maps coupled with Geographical Information System (GIS).

Four weeks after the initial administration of 126 questionnaires, 107 questionnaires (84.9%) were returned. From this, 5 questionnaires were discarded due to incomplete data provided. Thus, 102 questionnaires were regarded as valid yielding an overall percentage of 80.9%, still being a relatively accepted figure. Generalization was also made following the outcome of the sampled result.

To identify the types/composition and frequency at which these solid wastes were generated by the industries in the study area, the industries were provided with a list of solid waste types selected from works of literature. They were further instructed to indicate the rate at which they produce each of the identified solid waste types. Industries were given the preference to express their view using one of five Likert scales of very frequent (VF), frequent (F), neither (N)Infrequent (IF), and very infrequent (VIF).

The analysis of the ratings indicated by industries from the Likert scale adopted evolved into an index called the composition of solid waste index (CSWI). To arrive at CSWI, the weight values of 5,4,3,2, and 1 were respectively attached to very frequent (VF), frequent (F), neither (N) Infrequent (IF) and very infrequent (VIF). The index of each type/composition of solid waste was arrived at by dividing the summation of weight value (SWV) by the total number of responses. The SWV for each solid waste type was obtained through the addition of the productof the number of responses to each solid waste type and the respective weight value attached to each rating. Mathematically, manipulation for the computation of a five Likert scale was adopted as shown below.

$$SWV = \sum_{i=1}^{5} x_i y_i \qquad [1]$$

where : SWV= Summation of weight value; $x_{i=}$number of respondents to rating i;

$y_{i=}$ the weight assigned to a value (i=1,2,3,4,5)

The index for each identified solid waste type thus takes a value of between 5 and 1. The nearer the value to 5, the higher is the occurrence of that industry producing such type of solid waste under consideration.

$$CSWI = \frac{SW}{\sum x_i} \qquad [2]$$

EQA 55 (2023): 12-22

DOI: 10.6092/issn.2281-4485/16445

Based on the equation above, the mean index for each industry was computed. This was obtained by summing the indices of all solid waste types and dividing by the number of the identified solid waste type (n =12). Findings are as presented in Table 2.

Background Information / Characteristics of Industries

The frequency distribution and percentage of various variables as retrieved from various industries are summarized in Table 1.

Table 1. *Background information of industries.*

Variable	Frequency	Percentage
(%) Type of Industry		
Manufactoring	75	73.5
Processing/Packaging	22	21.6
Construction	4	3.9
Service	1	1.0
Years of Establishment		
10 and below	20	19.6
11-20	39	38.2
21-30	25	24.5
31-40	12	11.8
41-50	6	5.9
Day of operation per week		
5 days	16	15.7
6 days	66	64.7
7 dais	20	19.6
Hours of operation per day		
1-8hrs	33	32.4
9-12hrs	33	32.4
13-24hrs	36	35.3
Number of employees		
Less than 100	53	52.0
101-200	30	29.4
201-300	5	4.9
301-400	6	5.9
401-500	5	4.9
501 and above	3	2.9
Scale of operation		
Large	35	34.3
Medium	53	52.0
Small	14	13.7

DOI: 10.6092/issn.2281-4485/16445

Findings showed that 66% of the industries were into manufacturing activities. Also, 21% were processing/ packaging industries while 3% and 1% were construction and service industries respectively. This indicates that manufacturing industries dominate the study area engaged in the transformation of goods materials or substances into new products. The transformational process can be physical, chemical, or mechanical with very little presence in service industries.

Findings also revealed that about 20% of the industries were 10 years and below. Next to this, 38% were between 11 to 20years. In the same vein, 25% of these industries were established between 21 to 30years while 12% and 6% accounted for industries established between 31 to 40years and 41 to 50years respectively. The findings indicate that the majority of the industriesin the study area were established less than two decades back with a small number of older industries.

As presented in the Table below, findings show that 64% of industries in the study area operate six days per week. Next to this, 19% of the industries operate seven days a week while 15% of them operate five days per week. Consequently, findings show that 35% of the industries operate 24hours per day while 32% operate between 8 to 12hours. This implies that industries that operate for 6 days and 24 hours are more likely to generate a higher amount of solid waste due to the length of the working period as compared to others.

Findings showed that slightly above average (52%) of the industries had less than 100 workers. Similarly, 29% of the industries had 100 to 200workers. Furthermore, findings also showed that 4.9% of the industries have 201-300workers. In the same vein, findings show that 5.9% had 301-400workers. Also, findings show that 4.9% have 401 to 500workers while 2.9% have 501 workers and above. This reveals that although industries with a large number of workers exist but were at a relatively low percentage. This could be due to the unfavorable economic policy of the nation among other factors. Findings showed that 13% of industries were small-scaled while 34% and 52.0% large and medium scale respectively being the mostdominant.

Type and Composition of Solid Waste Generated

Presented in Table 2 are the types/composition of waste generated among industries in the study area with special emphasis on the rate at which these wastes are being generated. As presented above, findings showed that the average Composition of Solid Waste Index (CSWI) among industries was (2.52). On this note, the mean deviation of the waste generated showed that the waste carrying positive values (0.73, 0.54, 0.31, 0.18 & 0.03) were presently issues of concern in the study area while those with negative values (-0.04, -0.07, -0.29, -0.51,-0.54 &-0.67) were also generated but not at an alarming rate. Therefore, metal/steel (3.25) was the most important wastes generated in the study area. Next to this was paper/nylon (3.06). Also, findings show that plastic/rubber and solid chemicals (2.83) were also very important. Other wastes in the same hierarchy are timber/wood and electronic waste. On the other hand, findings showed that glasses/ceramics/bottles, textile, used batteries, cartons, food remains, and used tires are present but were at a very minimal and controllable proportion.

Table 2. *Determinant of Type/Composition of Solid Waste among Industries.*

	Frequency					Summantion		
Types/Composition solid waste	**VP (5)**	**F (4)**	**N (3)**	**IF (2)**	**VIF (1)**	**SWV**	**CSWI (2.52)**	**MD**
Metal & Steel	25	11	41	15	10	332	3.25	0.73
Paper & Nylon	33	13	8	23	25	312	3.06	0.54
Plastic & Rubber	26	13	14	17	31	289	2.83	0.31
Solid Chemicals	7	28	25	25	17	289	2.83	0.31
Timber/Wood	-	19	52	12	19	275	2.70	0.18
E-Waste	1	10	54	9	28	260	2.55	0.03
Glass/Ceramics/Bottles	2	4	59	13	24	253	2.48	-0.04
Textile	1	-	69	6	26	250	2.45	-0.07
Used batteries	-	7	46	12	37	227	2.23	-0.29
Cartons	5	6	13	39	39	205	2.01	-0.51
Food Remains	1	-	34	28	39	202	1.98	-0.54
Used Tyres	-	5	31	10	56	189	1.85	-0.67

DOI: 10.6092/issn.2281-4485/16445

Method of Waste Collection and Disposal

Presented in Table 3 are the methods of waste collection among the industries. Findings show that industries use one or more methods to collect their waste. Among methods available tothe industries, the big waste bag was widely used, having accounted for 40.8%. Next to this was large waste bin being 30.6%. The proportion of government-issued bins and garbage bags/old metal containers accounted for 16% and 12.2% respectively. This implies that the majority of theindustries made use of big waste bags. This may be due to affordability and ease of access as compared to other methods.

Presented in Table 3 are the methods of waste disposal adoptedin the study area. Findings showed that various waste disposal methods were employed by the industries. Among these methods, recycling was the most commonly used, having accounted for 27.8%. Next to this was disposal at designated dumpsites 25.7%. Findings also show that private solid waste managers accounted for 11.8% and the least used being disposal in dilapidated building/uncompleted building being 2.1%. It was evident that although a reasonable number of the industries use recycling as their method of disposal which is environmentally friendly the major problem still lies with the industries that dump waste in dilapidated buildings and vacant plots. It was also revealed that no industry in the study area disposes of their solid waste along the highway.

Table 3. *Method of waste collection and disposal.*

Variable	Frequency	Percentage (%)
Method of Collection		
Garbage Bags & Old Metal Containers	18	12.2
Big Waste Bags	60	40.8
Large Waste Bins	45	30.6
Government Issued Bins	24	16.4
Total	147**	100.0
Method of Disposal		
Burning/Incineration	12	6.4
Composting	11	5.9
Sanitary landfill	7	3.7
Lake/Dam	6	3.2
Designated dumpsite	48	25.7
Along high way	-	-
Vacant plot /Open space	17	9.1
Barrow/Cart pusher	8	4.3
Private solid waste manager	22	11.8
Dilapidated/Uncompleted building	4	2.1
Garbage power plant	-	-
Recycling	52	27.8
Total	187**	100.0

** This number exceeds the number of questionnaires administered because respondents utilized more than one waste collection and disposal method.

DOI: 10.6092/issn.2281-4485/16445

Agencies Responsible for Industrial waste management

As presented in Table 4, findings show that 48.1% of industrial wastes were managed by private agencies. Also, findings show that 34.3% were managed by the state government while 9.8% and 7.8% of the wastes are managed by industrial cooperation agencies, and cart pushers. This reveals that private agencies and the state government were the major actors in themanagement of industrial waste in the study area. Consequently, cart pushers also have a role toplay but their activities could bring about indiscriminate waste disposal.

As illustrated in Table 4, findings showed that 33.3% of the industrial solid wastes were collected monthly. Also, findings showed that 24.5% were collected weekly while 11.8%, 8.8%and 7.8% were collected fortnightly, twice a week, and every day respectively. However, due to the large rate of waste generation, 13% of the industries dispose of waste when necessary.

Table 4. *Waste management agency and rate of waste collection.*

Variable	Frequency	Percentage
Waste Management Agency		
State government	35	34.3
Private body	49	48.1
Industrial cooperation agency	10	9.8
Cart pushers	8	7.8
Total	102	100.0
Rate of collection		
Daily	9	7.8
Twice a week	9	8.8
Weekly	25	24.5
Fortnightly	12	11.8
Monthly	34	33.3
When necessary	14	13.8
Total	103	100.0

Presence of waste disposal facility and provider

In the Figure below, findings show that more than half of the industries (53%) do not have waste disposal facilities within their locality. This may likely be the major cause of indiscriminate and harmful disposal of industrial solid waste.

Presented in the table above are the various providers of waste disposal facilities.Findings showed that 63.8% of disposal facilities were provided by the state government. Also, findings showed that 27.7% of the facilities were self-provided while 8.5% were provided by private waste managers. This implies that the major provider of waste disposal facilities was the state government. Findings also reveal that the local government has no role to play in thedisposal of waste in any way within the locality.

Table 5. *Availability of waste disposal facility and provider*.

Variable	Frequency	Percentage
Presence of Disposal Facility		
Yes	35	34.3
No	49	48.1
Total	102	100.0
Provider of Facility		
Your company	09	7.8
State Government	09	8.8
Privare solid waste management	25	24.5
Total	47**	8.5

**The number of facility providers is not up to the number of questionnaires administered because only respondents that answered "yes" in the previous section were required to provide answers in this section

Causes and steps to control indiscriminate industrial solid waste disposal

Findings showed with Table 6 that issues attached to the indiscriminate waste disposal in the study area were disposal facilities not in proximity (16.4%), inadequacy in disposal facilities (15.6%) and lack of effective waste management agencies (15.1%) being the major causes. Furthermore, findings revealed that 10.5% and 10.2% indiscriminate waste disposal was owing to carelessness and there were no open spaces where waste could be disposed.

DOI: 10.6092/issn.2281-4485/16445

Table 6. *Causes and steps to control indiscriminate industrial solid waste disposal*

Variable	Frequency	Percentage
Reason for Indiscriminate Waste Disposal		
Disposal facilities are not provided	61	15,6
Facilities are not in proximity to the industries	64	16,4
No legislation restricting waste disposal	38	9,7
Low level of danger awareness	34	8,7
No fee is charged	11	2,8
Carelessness	41	10,3
Ignorance	22	5,6
No open space where waste is disposed	40	10,2
Lack of effective waste management agencies	59	15,1
The cost of the waste collection is too high	21	5.4
Total	391**	100.0
Steps to Stop/Control indiscrimate waste disposal		
Putting in place relevant and enforceable legislations	77	14,7
Arresting and prosecuting defaulters of the laws	58	11,0
Provision of storage facilities by government and agencies	84	16,0
Renovation of existing waste collectors	82	15,6
Sensitization as to the negative impacts waste posses	72	13,8
Regulation of private waste collection and proper licensing	68	12,9
Better maintenance and management	84	16.0
Total	525**	100.0

** This number exceeds the number of the questionnaire administered because respondents suggested more than one cause and step to combat the indiscriminate industrial solid waste disposal

Finally, findings showed that 5.4% and 2.8% of the same issue were caused by the cost of the waste collection being too high and no fee charged. It is evident that the study area lacks the provision of adequate waste management facilities and in other cases of indiscriminate waste disposal, carelessness on the part of the industries were the underlying factors. As summarized in Table 6, findings show that the percentage differences among the solutions to the indiscriminate waste management as identified by the respondent were very close. The most important control measures as selected by the respondents were the provision of storage facilities and better maintenance and management (16%). Next to this was the renovation of existing waste collectors (15.6). Also, findings show 14% felt putting in place relevant and enforceable legislation would help curb the menace while 11% and 12% perceived the solution to be the arresting/prosecuting defaulters and regulation of the private waste collection and proper licensing respectively.

Conclusion and Recommendation

The study assessed solid waste management practices among industries in Ota, Ogun State with its central thrust towards proposing an institutional framework that could be used to improve the solid waste management processes. The study identified various waste management issues and this was achieved through the use of personal observation and interviews at the elementary stage and questionnaires in collecting information as deemed fit to the research work. It was observed among industries in the study area that the most frequently producedwaste was metal/steel and paper/nylon which should be given more attention as compared to other types of waste generated.

Also, it was established that the major mode of waste collection was big waste bags and large waste bins with an abundant amount of this waste being mixed up at both the point of collection and disposal. Many industries in the study area adopted recycling and

DOI: 10.6092/issn.2281-4485/16445

designated dumpsites as their method of waste disposal but on the other hand, some industries dump their waste in dilapidated buildings and vacant plots. Furthermore, the majority of the waste collection was seen as a state and private waste manager's responsibility while the local government who is closer to these industries had no role to play.

Based on the pressing issue above, the government should make the collection of industrial wastes a local government responsibility since they are closer to the industries. Also, a central waste management dump site should be provided by the local government or through a public-private partnership to help manage solid hazardous waste from industries. Legislations of strict laws and their enforcement should be ensured and penalties should be given wherecompliance seems abortive. The government should also provide basic facilities, equipment, adequate funds, and qualified personnel to manage the various wastes generated. On the other hand, industries should provide an in-house waste management department which will be saddled with the responsibility of sorting the various types of waste produced. First-hand communication between the waste management industries should be adopted to enhance a more efficient waste management process. Frequent sensitization of industries on the impact and general procedures of handling waste should be dwelled upon during industrial organization gatherings and meetings for small-scale industries.

References

ADEKOYA N., BISHOP C. (1992) Failure of the Environmental Health Program in NigeriaC: oncern for Health Planners in Developing Nations. International Journal of Environmental Health Research, 2:167-170. https://doi.org/10.1080/09603129209356749

AMINU S., AHMED F. (2021) An overview of hazardous waste in Nigeria. Dutse Journal of Pure and Applied Sciences, 7(4b):214-221. https://doi.org/10.4314/dujopas.v7i4b.22

ANAND P. B. (1999) Waste management in Madras revisited. Environment and Urbanization, 11(2):161–176. https://doi.org/10.1177/095624789901100214

AWUCHI, C.G., HANNINGTON T., AWUCHI C.G., IGWE VS; AMAGWULA I.O. (2020) Industrial waste management, treatment, and health issues: wastewater, solid, and electronic wastes. European Academic Research 8(2):1081-1119. ISSN: 2286-4822 AYALA (2011) Agro-industrial potential of exotic fruits by-products as a source of food additives. Food Res. Int. 44, 1866-1874.

CHADAR S.N, CHADAR K. (2017) Solid waste pollution: a hazard to environment. Recent Adv Petrochem Sci 2:41–53. http://dx.doi.org/10.19080/RAPSCI.2017.02.555586

CHEN D, YIN L, WANG H, HE P. (2014) Pyrolysis technologies for municipal solid waste: a review of waste management. https://doi.org/10.1016/j.wasman.2014.08.004

CZAJCZY´NSKAA D, NANNOU T, ANGUILANO L, KRZY˙ ZY´NSKA R, GHAZALD H, SPENCERE N, JOUHARA H. (2017) Potentials of pyrolysis processes in the waste management sector. 1st international conference on sustainable energy and resource use in food chains, ICSEF 2017, Berkshire, UK Energy Procedia;123:387–94. http://dx.doi.org/10.1016/j.tsep.2017.06.003

COLLINS O. UGWU, CHIGBOGU G. OZOEGWU, PAUL A. OZOR, NDUKWE AGWU, C. MBOHWA. (2021) Waste reduction and utilization strategies to improve municipal solid waste management on Nigerian campuses. http://doi.org/10.1016/j.jfueco.2021.100025

EPA (1995). Decision maker guide to solid waste management. Vol. 2, United State Environmental Protection Agency. Washington D.C. Pp: 372.

FEDERAL ENVIRONMENTAL PROTECTION AGENCY (1991): Guidelines and Standard for Industrial Effluents, Gaseous emission, and Hazardous waste management in Nigeria.

GEYER, R., JAMBECK, J.R., LAW, K.L. (2017) Production, use, and fate of all plastics ever made – supplementary Information. Sci. Adv. 25–29. https://doi.org/10.1126/sciadv.1700782

HU Y., ZHAO L., ZHU Y., ZHANG B., HU G., XU B., HE C., DI MAIO F.. (2021) The fate of heavy metals and salts during the wet treatment of municipal solid waste incineration bottom ash.

DOI: 10.6092/issn.2281-4485/16445

Waste Management, 15(121):33-41. https://doi.org/10.1016/j.wasman.2020.11.049

JUSTICE M. (2021) "Fisherfolk's Perception of and Attitude to Solid Waste Disposal: Implications for Health, Aquatic Resources, and Sustainable Development", Journal of Environmental and Public Health, vol. 2021, Article ID 8853669, 12 pages, 2021. https://doi.org/10.1155/2021/8853669

MOHAMMAD AMIN KARAMI, MOHSEN SADANI, MEHDI FARZADKIA, NEZAM MIRZAEI, ANVAR ASADI (2015) System Analysis of Industrial Waste Management: A Case Study of Industrial Plants Located Between Tehran and Karaj. https://doi.org/10.4103/2277-9183.157706

MOMODU, N.S., DIMUNA, K. O. AND DIMUNA, J.E. (2011) "Mitigating the Impacts of Solid Wastes in Urban Centres in Nigeria", Journals of Human and Ecological Sciences vol 1 34 no. pp 125-133. http://dx.doi.org/10.19044/esj.2016.v12n23p155

NATTAPON LEEABAI, CHINNATHAN AREEPRASERT, CHANOKNUNT, KHAOBANG, NITI VIRIYAPANITCHAKIJ, BUNDIT BUSSA, DILIXIAITI DILINAZI, FUMITAKE TAKAHASHI (2021). Waste Management Journal, 121:153-163. Global Engineering Course for Development, Tokyo Institute of Technology, G5-601, Suzukake, 4259, Nagatsuta, Midori-ku, Yokohama 226-8503, Japan. http://doi.org/10.1016/j.wasman2021.05.039

OCHUKO MARY OJO (2014) Solid Waste Management in Obantoko Area of Abeokuta, Nigeria. Journal of Emerging Trend in Engineering and Applied Science (JETEAS) 5(2): 111-115. ISSN: 2141-7016

OLADEYEDE, S.A; AYEDUN, C.A; DURODOLA, O.D. AND PETER, J.N. (2014) Residential Solid Waste Management in Sango-Ota, Ogun State: To Recycle or Not to Research on Humanities and Social Sciences, 4(26). pp. 189-194. ISSN: 2225-0484

ONIPEDE A.I.., BOLAJI B.O. (2004) Management and Disposal of Industrial Waste. Nigerian Journal of Mechanical Engineering, 2(1), Department, University of Ado-Ekiti, Nigeria

PATHAK A.K., SINGH M.M., KUMAR V. (2011) Composting of municipal solid waste: a sustainable waste management technique in indian cities – a review. Int J Curr Res, 3:339–46. ISSN: 0975-833X

RASMI P. (2018) Impact of Industrialization on Environment and Sustainable Solutions Reflections from a South Indian Region. Centre of sustainable development, Indian Institute of Corporate Affairs, Manesar, Gurugram, India. http://dx.doi.org/10.1088/1755-1315/120/1/012016

RINKESH W. (2018) What is Solid Waste Management? Sources and Methods of Solid Waste Management. Conserve Energy Future. https://www.conserve--energy-future.com/sources-effects-methods-of-solid-waste-management.php

THE ARENA GROUP (2022) Industrialization and Economic Development. Owlcation, SAIF 113SB, https://owlcation.com/social- sciences/