Effect of Waste Management on Environmental Sustainability in Port Harcourt

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Abstract
The study examined the effect of waste management on environmental sustainable development in Port Harcourt. Survey and correlational research designs were adopted. A sample size of 400 subjects was used for the study. This comprised of 50 staff of the Port Harcourt Ministry of Environment, 50 staff of Port Harcourt Environmental Sanitation Authority, and 300 residents of Port Harcourt. The Waste Management Questionnaire (WMQ) and Sustainable Development Questionnaire (SDQ) instruments were used. The instruments were validated by experts in Education and Environmental Science. The reliability of the instruments was established using the Cronbach Alpha method to obtain indices of 0.84 and 0.75 for WMQ and SDQ respectively. Data obtained was analyzed using regression analysis. The result revealed that: out of the four independent variables correlated and regressed with the criterion measure of sustainable development, Waste Regulation was the best predictor. It had the strongest predictive power than the Waste Recycling, Waste Reuse and Waste Composting. The establishment of refuse recycling plant in Port Harcourt to transform waste to other products, alongside a proper framework set up to encourage active Private Sector Participation in the business of waste disposal and management in Port Harcourt were among the proffered recommendations.

Keywords: Recycling, Reuse, Composting and Regulation, Environmental Sustainability, Port Harcourt.

Background of the Study
Waste management, as a prominent problem confronting developing Countries is the organized and systematic channeling of waste through practically, economically and technically appropriate recovery or disposal route in accordance with acceptable environmental safeguards. Effective and safe waste management programmes, require a total annual investment in developing countries of $15.7 million or $16 billion, of which $2.7 million or $3 billion is required exclusively for the management of waste (Adewumi, 2001). The post independence era in Nigeria (comprising the 36 states and a federal capital territory setting) has witnessed series of political and socio-economic development, increase in population, and industrialization, resulting to the astronomical increase in the volume and diversity of solid waste that are generated and inefficiently managed leading to environmental pollution.
Ineffective management of waste has militated against the attainment of a greener environment and sustainability in Nigeria. According to Mabogunje (1996) Nigerian cities have been described as some of the dirtiest, the most unsanitary and the least aesthetically pleasing in the world. Many industries embark on unsustainable practices by discharging their wastewater into surface waters [oceans, seas and streams] more often than not without any form of remediation or treatment. This has several deleterious consequences such as using partially diluted, polluted water for irrigation, reduction in the soil quality and nutrients, useful and beneficial aquatic flora and fauna, reduction in quality and quantity of harvested agricultural produce as a result of irrigation with unwholesome water consumption of agricultural produce.

Environmental sustainability is the process of making sure current processes of interaction with the environment are pursued with the idea of keeping the environment as pristine as naturally possible based on greening (which refers to strategies and techniques that protect and restore ecology within the urban environment). Thus, creating sustainable green spaces which are not only desirable, but profitable can begin with effective waste management that leads to the development of agriculture, protection and restoration of aquatic areas like streams, swamps, beaches and other aquatic systems, and the enhancement of the aesthetics and designs of asphalt roads, concrete sidewalks, and other paved surfaces (Fobil, Kolawole, Hogarh, Carboo, Rodrigues, 2010).

The various stages involved in waste management according to Adewumi (2001) are: generation (as the weight of material discarded as solid waste by one person in one day), storage (keeping solid waste in place or containers by individuals for the refuse collection agency or agents), collection (transportation of the solid waste from the point of storage to the point of disposal), and disposal (as the final destination of solid waste at approved dump sites). However, current challenges calls for an Integrated waste management policy as a strategic approach to sustainable management of wastes covering all sources and aspects of generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency (United Nations Environment Programme - UNEP, 2012).

Sustainable Integrated waste management is the coordinated use of a strategically chosen set of waste management options like recycling, reuse, composting, and regulation. Each of which play specific roles in prevention and reduction in the effects of waste, its transportation, and in material and energy recovery from wastes towards achieving maximum resource efficiency. This involves the coordinated use of a set of waste management methods, each of which can play a role in an overall Municipal Solid Waste Management plan (Global Development Research Center - GDRC, 2012).

According to US Environmental Protection Agency (2006) Recycling (as a difficult or too expensive compared with producing the same product from raw materials or other sources) is processing used materials (waste) into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from landfill) by reducing the need for "conventional" waste disposal, and lower greenhouse gas emissions. Recyclable materials include many kinds of glass, paper, polystyrene, metal, plastic, textiles, and electronics. Although similar in effect, the
or other reuse of biodegradable waste such as food or garden waste is not typically considered recycling. Materials to be recycled are either brought to a collection center or picked up from the curbside, then sorted, cleaned, and reprocessed into new materials bound for manufacturing. Another form of recycling is the salvage of certain materials from complex products, either due to their intrinsic value (e.g., lead from car batteries, or gold from computer components), or due to their hazardous nature, e.g., removal and reuse of mercury from various items (Zimring, 2005; Sepúlveda, Schlup, Renaud, Streicher, Kuehr, & Hagelüken, 2010).

Critics dispute the net economic and environmental benefits of recycling over its costs, they argue that the costs and energy used in collection and transportation outweighs the costs and energy saved in the production process; also that the jobs produced by the recycling industry can be a poor trade for the jobs lost in logging, mining, and other industries associated with virgin production; and that materials such as paper pulp can only be recycled a few times before material degradation prevents further recycling (United States Geological Survey, 2006). Proponents of recycling dispute each of these claims, and the validity of arguments from both sides has led to enduring controversy (Brown & Buranakarn, 2003).

Lavee (2007) emphasized that for a recycling programme to work, having a large, stable supply of recyclable material is crucial. Three legislative options used to create such a supply include: mandatory recycling collection laws (set recycling targets for the diversion of the cities certain waste materials), container deposit legislation (where the consumer is refunded the surcharge upon return of certain containers, like glass, plastic, and metal) and mandatory collection laws (outright ban on the disposal of certain waste like oil, old batteries, tires and garden waste, possibly leading to increased illegal dumping).

Reuse is a means to prevent waste from entering the landfill, improve our communities, and increase the material, educational and occupational wellbeing of our citizens by taking useful products discarded by those who no longer want them and providing them to those who do. In many cases, reuse supports local community and social programs while providing donating businesses with tax benefits and reduced disposal fees. The environmental benefits of many reuse programs have evolved from local waste reduction goals because reuse requires fewer resources, less energy, and less labor, compared to recycling, disposal, or the manufacture of new products from virgin materials. Reuse provides an excellent, environmentally-preferred alternative to other waste management methods, because it reduces air, water and land pollution, reduces greenhouse gas emissions, a contributing factor to global warming, limits the need for new natural resources, such as timber, petroleum, fibers and other materials (US Environmental Protection Agency, 2006).

While manufacturing new products drains our limited natural resources, and disposing of unwanted materials pollutes our environment, our communities face difficulties getting the affordable goods they need. One way to prevent waste, improve our communities, and increase the material well-being of our citizens is to take useful building materials, office furniture and supplies, computers and electronics, art materials, medical equipment and supplies, surplus food items and equipment and household items discarded by those who no longer want or need them to those who
really need them (World Commission on Environment and Development, 2011).

Consequently, Reusing an item means that it continues to be a valuable, useful, productive and replaces new items that would utilize more water, energy, timber, petroleum, and other limited natural resources in their manufacture. Businesses can save significant dollars in disposal by reselling or donating items that are no longer needed. Many chemicals and solvents that are no longer useful to one organization, can be used in other applications by other organizations. This method of "materials exchange" results in disposal savings by the generating company, and saving in the purchase of the material by the recipient organization. Reuse adds value! (REDO, 2010). Furthermore, the Lagos State government has domesticated the waste reuse programme, through the introduction of the "Waste To Wealth" programme, where the residents are paid certain amount of money for returning each Kilogram of used waste materials returned at the designated spots or points. This is not only an indirect way of enhancing reuse but ensuring proper sanitation practice and proper management of the non bio degradable and its effects from our environment.

According to Simmons, Goldstein, et al (2006) Composting is the process of biological decomposition of waste under aerobic and haemophilia conditions which break down organic materials, leaving a humus rich residue, the compost. Savage & Demers (1996) emphasized that the composting of waste in any settlement reflects the nature and composition of the human activities in that settlement. Therefore, waste materials such as paper, wood, dust and garbage, animal droppings, carcass, cellophane bags and leaves, empty sachet, plastic cans, cartons, and abandoned automobiles from industries, toxic industrial wastes, and agricultural wastes undergoes exposure to heat at high temperature of 1,250°F or between 1700-1800°C in either in locally improvised or modern incinerators in homes, schools, markets and other public places in Nigeria.

Waste composting is tended to assist in planning, policy development, and infrastructure sizing decisions for various facets of an integrated waste management programme, that. But it is influenced by multiple factors like available funds, program objectives. Thus, the design and implementation of a sound characterization methodology, which ultimately defines the accuracy and level of detail, can vary. (Eleazar, et al, 1997).

Managing waste through modern and effective regulation is essential to success both now and for the future. In order to reduce waste production and to significantly increase the reuse, recycling and sustainable treatment of waste, a modern and effective approach to regulation is required. We also need a system that people and businesses can trust and respect however; the situation is complex as there are local, regional, national and global issues to consider.

The general principles of better regulation designed by the government should emphasize the:

- elimination of outdated or unnecessary provisions in legislation;
- consolidation, streamlining or merging regulatory regimes where possible;
- regulation, inspection and enforcement of sound risk principles;
- ensure where companies break the law that enforcement can be swift.
and effective;

- minimization of administrative burdens on companies and regulators wherever possible;
- empower regulators to enforce regulations in a fair, consistent and proportionate manner;
- promotion of best practices and advices to regulate companies wherever possible.

Waste regulation activities depend on the culture, technological advancement and adaptable policy framework of any country. Hence, the inability of managing household and industrial or toxic waste often leading to soil and ground water pollution in one country, may eventually overlap into waste management problems in another country (Agyeman, 2005).

Sustainable waste management service delivery in Nigeria according to Fobil et al (2010) is confronted with include inadequate funds for waste collection, poor urban planning leading to lack of access routes for waste removal, inadequate sanitation facilities, bad habits on the part of residents, low service coverage, among others. This also applies that there ought to be a complete policy shift on the collection, transportation and disposal of urban waste to move from the control of local government authorities constitutionally, responsible for the disposal of waste in Nigeria, due to their lack of expertise or resources, poor planning, and lack of proper understanding of the various issues involved in the handling and management of municipal waste (Adewumi, 2001). To increased involvement of the private sector either 'spontaneously' in a free market setting or encouraged through local authorities, Non-Governmental Organisation (NGOs) or Community-Based Organisations (CBOs) in a hybrid couple-system (Bartone, 1999; Ogunwalere, 2000).

The existing waste management framework appears to be in line with this hybrid system, but the country has not made much progress in its implementation probably due to inappropriate implementation plans.

Problem Specification

Waste generation as well as an increase in pollution resulting from the expansion of industry and growth in large urban areas (such as Lagos, Kano, and Port Harcourt) has created environmental problems, thus, hampering sustainability and greening of the cities. It has been noted that the populace in these densely populated states in Port Harcourt have consistently engaged in poor waste disposal habit due to ignorance and poverty.

Over the years poor waste management culture coupled with the inability of the regulatory agencies to sort waste via household, industrial and toxic waste, has affected the quality of life of Nigerians: environmentally, socially, economically, and health wise. Leading to air and water pollution, health problems from convulsion, dermatitis, irritation of nose/throat, a plastic anaemia, skin burns, chest pains, blood disorders, stomach aches, vomiting diarrhoea, malaria, and lung cancer, and the possible evacuation of people from such hazardous areas perceived to be undesirable and unlivable.

It is based on the foregoing, that this study intends to examine waste management as an inevitable bye product from human activities that can be pursed without causing damage to the natural environment hence sustainability.

Specifically, the purposes of the study were to:

1. Determine the impact of waste
recycling on environmental sustainability in Port Harcourt.
2. Determine the impact of waste reuse on environmental sustainability in Port Harcourt.
3. Determine the effects of waste composting on the sustainability of the environment in Port Harcourt.
4. Determine the extent waste regulation can influence environmental sustainability in Port Harcourt.
5. Determine the joint contribution of waste: recycling, reuse, composting and regulation on environmental sustainability in Port Harcourt.

The following research questions guided the study:

1. What is the relative contribution of waste management variables to environmental sustainability in Port Harcourt?
2. What is the joint contribution of waste management variables to environmental sustainability in Port Harcourt?

Scope of the Study
The scope of the study is on waste management and environmental sustainable development in Port Harcourt. Furthermore, waste management (via recycling, reuse, composting, and regulation) is the independent variables while environmental sustainable development is the dependent variable.

Significance of the Study
This study would be beneficial to the individuals, community, government, municipal authorities and the society at large.

Individuals would see the need to inculcate high ethical standards and environmental sustainable practices in the generation and disposal of solid waste. Individuals and Institutions would be encouraged to turn to waste minimization, reuse, recycling and composting, which are important elements of sustainable integrated waste management.

The community would come to the realization that waste management service is not-exclusive (i.e. benefiting all sections of the society), and non-rivaled, meaning that any resident can enjoy the service without diminishing the benefits of others. The government and municipal authorities would work out practical and feasible strategies for implementing waste management programmes either for private sector or citizenry participation.

Methodology
The study adopted the descriptive survey and correlational research designs. The population of the study consists of staff of the Rivers State Ministry of Environment, Environmental Sanitation Authority, and all residents of Port Harcourt City Local Government Area of Rivers State. A multistage cluster sampling technique was used in the selection of fifty Staff each from the Rivers State Ministry of Environment and Environmental Sanitation Authority and three hundred residents across the Borokiri, D line, Diobu and G.R.A. strata of Port Harcourt City. This constituted a sample of four (400) respondents used for the study. The instruments for data collection was Waste Management Questionnaire (WMQ) and Sustainable Development Questionnaire (SDQ) made up of 16 item each were validated by experts in Education and Environmental Science. The instrument was patterned after a modified rating scale of “Strongly Agree”, “Agree”, “Disagree”, and “Strongly Disagree”. The reliability of the
instruments was established using the Cronbach Alpha method to obtain indices of 0.84 and 0.75 for WMQ and SDQ respectively. The data collected was tabulated and subsequently analyzed using regression analysis.

Results

a) Relative contributions of independent variables to the prediction.

Table 1: Relative contributions of waste management variables to sustainable development in Port Harcourt.

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable</th>
<th>R</th>
<th>$R^2$</th>
<th>SE</th>
<th>F-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Waste Reuse</td>
<td>.221</td>
<td>.049</td>
<td>6.94807</td>
<td>18.580</td>
<td>.000</td>
</tr>
<tr>
<td>3</td>
<td>Waste Compositing</td>
<td>.319</td>
<td>.102</td>
<td>6.75202</td>
<td>41.020</td>
<td>.000</td>
</tr>
<tr>
<td>4</td>
<td>Waste Regulation</td>
<td>.386</td>
<td>.149</td>
<td>6.57100</td>
<td>63.513</td>
<td>.000</td>
</tr>
</tbody>
</table>

* Significant at < .05.

Table 1 shows the relative contributions of Waste Recycling, Waste Reuse, Waste Compositing and Waste Regulation to the observed variance in the criterion variable (Sustainable Development) as indicated by the R and $R^2$ values at the various steps of the regression analysis. It was found in Table 1 that Waste Recycling had R and $R^2$ value of .162 and .026 respectively. Waste Reuse entered the equation at step 2; and the cumulative R was .221 and $R^2$ was .049, waste compositing entered the equation at step 3; and the cumulative R was .319 and $R^2$ was .102 and the last step, Waste Regulation had R and $R^2$ value of .386 and .149 respectively. The values corresponding to the four steps involved in the multiple regressions were significant at p<.05 level. The results in Table 1 confirm that Waste Regulation was the best predictor of Sustainable Development in the Port Harcourt when compared with Waste Recycling, Waste Reuse, and Waste Compositing.

Table 2: The Betas of the Predictor Variables to the prediction of algebra performance

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$</th>
<th>SEB</th>
<th>Beta</th>
<th>T</th>
<th>Sig.T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Recycling</td>
<td>.406</td>
<td>.127</td>
<td>.146</td>
<td>3.189</td>
<td>.002*</td>
</tr>
<tr>
<td>Waste Reuse</td>
<td>.405</td>
<td>.100</td>
<td>.184</td>
<td>4.050</td>
<td>.000</td>
</tr>
<tr>
<td>Waste Compositing</td>
<td>1.354</td>
<td>.219</td>
<td>.284</td>
<td>6.175</td>
<td>.000</td>
</tr>
<tr>
<td>Waste Regulation</td>
<td>1.137</td>
<td>.168</td>
<td>.311</td>
<td>6.766</td>
<td>.000</td>
</tr>
<tr>
<td>Constant</td>
<td>6.218</td>
<td>3.905</td>
<td>1.592</td>
<td>.112</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at < .05.
Table 2 gives the predictor variables in the regression equation, the Beta values, and significant T matching the variables regressed against the dependent variable. A peek at Table 4 reveals that the Beta values for Waste Regulation was found to be highly significant ($\beta = 1.137; t = 6.766, p<.01$). Looking at the results in Table 3, the value pulled by Waste Regulation was the highest when compared with the values pulled by Waste Recycling ($\beta = .406; t = 3.189, p>.01$), Waste Reuse ($\beta = .405; t = 4.050, p>.01$) and Waste Composting ($\beta = 1.354; t = 6.175, p>.01$) respectively. This confirms the results in Table 1 where Waste Regulation was earlier revealed to be the best predictor of Sustainable Development in Port Harcourt.

b) The joint contribution of independent variables to the prediction

The correlation matrix of the measured variables was presented in Table 3. Results on Table 3 showed that Waste Recycling, Waste Reuse, Waste Composting and Waste Regulation are significantly correlated with sustainable development ($R = .162, p<.01$), ($R = .221, p<.01$), ($R = .319, p<.01$) and ($R = .386, P<.01$), respectively. This indicated that Waste recycling, Waste Reuse, Waste Composting and Waste regulation were predictors of Sustainable development in Port Harcourt.

Table 3: Means, standards deviations and inter-correlations among predictor and sustainable development in Port Harcourt for total sample (N = 364)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Waste Recycling</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Waste Reuse</td>
<td></td>
<td>.127*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Waste Composting</td>
<td>-.117*</td>
<td>-.015</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Waste regulation</td>
<td></td>
<td>.082</td>
<td>.073</td>
<td>.175**</td>
<td>1</td>
</tr>
<tr>
<td>Sustainable</td>
<td>.162**</td>
<td>.221**</td>
<td>.319**</td>
<td>.386**</td>
<td>1</td>
</tr>
</tbody>
</table>

*: Correlation is significant at the 0.05 level (2-tailed).
**: Correlation is significant at the 0.01 level (2-tailed).

Table 4: Summary of Regression Analysis between the predictor variables and sustainable development in Port Harcourt.

<table>
<thead>
<tr>
<th>Regression analysis</th>
<th>Analysis of Variance (ANOVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>SS</td>
</tr>
<tr>
<td>R=.525 Regression</td>
<td>5055.482</td>
</tr>
<tr>
<td>R²=.275 Residual</td>
<td>13317.296</td>
</tr>
<tr>
<td>SE=6.09061 Total</td>
<td>18372.777</td>
</tr>
</tbody>
</table>

*Significant at p<.05
Table 4 shows the values of the parameters of the regression analysis between the predictor variables and Sustainable development in Port Harcourt. The results of the analysis showed that predictor variables predicted Sustainable Development. The predictor variables taken against the criterion variable yielded a coefficient of multiple correlations (R) of .525 and multiple correlation square ($R^2$) of .275. The $R^2$ value translated into 27.5% of the observed variance in Sustainable Development in Port Harcourt. The analysis also gave a Standard Error (SE) of 6.09061 and F-value of 34.071 significant at an alpha level of .05.

**Discussion**

The results contained in Table 1 and 2 are quite enlightening and useful. All the predictor variables investigated were found to contribute differently to the prediction of sustainable development in Port Harcourt. However, Waste Recycling, Waste Reuse, Waste Compositing and Waste Regulation contributed significantly to the observed variance in the criterion variable in that order. Waste Recycling accounted for 22.1% of the variance in sustainable development in Port Harcourt, while Waste Regulation combined with Waste Recycling. Waste Reuse and Waste Compositing accounted for 43.6% of the variance in Sustainable Development in Port Harcourt. This means that 34.3% of the variance in sustainable development is accounted for by other variables unexplained by the data. These findings suggest that a few other latent and observable variable that lie outside the scope of the present study should be included in a similar study to provide a more comprehensive conceptualization of the other variables determining Sustainable Development in Port Harcourt.

The results on Table 4 indicated that 27.5% of the variance in sustainable development was accounted for by the predictor variables taken together. The relationship between sustainable development in Port Harcourt and the joint contributions of the predictor variables (Waste Management) were high as shown by the coefficient of multiple correlation (R = .525). Thus, the predictor variables investigated when taken together could, to some extent predict performance in university algebra among undergraduate computer science students involved in this study. The F-value (34.071) as revealed in the ANOVA which was significant at alpha level of .05 lend credence to the fact that the predictor capacity of the predictor variables of this study did not occur by chance even though a large proportion of the variance in sustainable development was unexplained by the current data.

**CONCLUSION**

The results of this study have revealed that out of the four independent variables correlated and regressed with the criterion measure of sustainable development, Waste Regulation was the best predictor. It had the strongest predictive power than the Waste Recycling, Waste Reuse and Waste Compositing. This implies that an integrated waste management programme incorporates healthy planning, policy development, technological advancement and infrastructure sizing, thereby resulting to environmental sustainability.