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Research Article

Solid Waste Management in Lagos State, Nigeria: Evaluating the Environmental Impact and Policy Effectiveness of Waste-To-Energy Initiatives

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Abstract

The study examined the effectiveness of the solid waste management policy on environmental hazard and waste to energy initiatives in Lagos State, Nigeria. In line with the objectives of the study, two hypotheses were formulated. Primary and secondary data were sourced for the study. For the primary data, A survey was carried out and a structured questionnaire was used to generate information from Lagos State Ministry of Environment and Water Resources; Lagos State Waste Management Authority (LAWMA); Lagos State Environmental Protection Agency (LASEPA); Private Sector Partners (PSPs); Lagos Recycler Association (LAGRA) and selected representatives of the end-users across the 20 local governments and 37 Local Community Development Areas (LCDAs) in Lagos State. Regression analysis and Pearson coefficient correlation were used to test the hypotheses. All the data generated were processed through the use of Statistical Package for Social Sciences (SPSS). Key informant interviews (KII) and focused group discussions (FGD) were also conducted. For the second data, information was sourced from the library, textbooks, journal articles, bulletins, the internet and policy documents. The findings of the study revealed that: solid waste disposal has a significant effect on environmental hazard reduction strategy on air pollution management in Lagos State, Nigeria; the incessant in hazard and secondly, a significant effect exists between solid waste management policy and waste-to-energy initiative. The study therefore concluded, among others that building an institutional capacity to support the waste-to-wealth and waste-to-energy initiative for effective solid waste management are driving force for promoting the Gross Domestic Product (GDP) of Lagos State. The government also needs to create public orientation on the need for environmental hygiene and waste disposal techniques to reduce environmental hazards and infectious diseases that may affect the plan of the state to become a mega-city.

Keywords: Environmental hazard; public policy; solid waste; waste-to-energy; management.

Introduction

The escalating danger of environmental damage resulting from inadequate solid waste disposal has emerged as a critical global issue. In Nigeria, especially Lagos State, rapid urbanisation and population expansion have intensified the solid waste management challenge [1]. The state's deficient waste disposal infrastructure and ineffective policy execution have resulted in significant environmental dangers, such as air and water pollution, soil contamination, and public health threats [2].

In light of these issues, waste-to-energy (WtE) efforts have garnered interest as a sustainable approach to solid waste management and energy generation. The effectiveness of these activities is significantly dependent on well-organised policies and regulatory frameworks [3]. Lagos State, as one of Africa's most populated cities, necessitates a thorough assessment of its solid waste disposal policies and waste-to-energy programmes to alleviate environmental risks. This study seeks to address the information deficit by assessing the environmental consequences and policy efficacy of waste-to-energy programmes in Lagos State.

This study objectives are to: assess the impact of solid waste disposal policy on the mitigation of environmental hazards in Lagos State, Nigeria; and also, to evaluate the effectiveness of solid waste management policy on waste-to-energy initiatives in Lagos State, Nigeria.

This study provides significant insights for policymakers, stakeholders, and researchers by analysing the current policy framework, waste management practices, and environmental implications. The results aid in formulating evidence-based policies and strategies to enhance solid waste management and waste-to-energy projects in Lagos State, hence promoting environmental sustainability and public health.

Literature Review

As the world grows in population, policymakers focus on solid waste management. Nonetheless, this has pushed policymakers' responsibilities beyond mere regulation of waste, collectively, and toward generating revenue across the country. Several policies have been enacted in Nigeria to control solid waste. However, given the nation's population growth, those policies have not been able to meet societal needs regarding waste generation, even though many scholars have praised policymakers for effective solid waste regulation, particularly in Lagos. However, the rate at which homes, schools, local businesses, and industries manage waste is unsatisfactory. Others argue that the government's waste policy lacks policy evaluation and monitoring. Importantly, this part of the study help finds gaps in the literature [4].

Solid waste management as the application of new ideas and procedures to assure proper management of solid waste transportation and disposal [5]. The growing global concern about environmental health necessitates trash management and disposal in the most environmentally friendly and acceptable manner. [21]Solid waste management is an almost usage and disposal of collected trash. The planning procedure that coordinates goals and objectives is called an operational strategy. Since the goals of the more numerous organisations are the activities framework, which must foresee needs as they evolve over time. The expenses of solid waste management are significant, particularly for process ultimately disposal. Trash collection techniques include going hallway or using bins or collective trash cans [5].

According to the European Commission (EC), one of most significant solid waste management practises is recovery, composting, and landfill/open dump sites. Strategic planning is an essential tool in the practises and processes of solid waste management. Contaminants and inorganic materials, construction waste, discard rims, sheet, corrugated, polymers, fabrics (such as material and leather), bottle, lumber, firewood, dead animals and quills, refuse oil and grease, fly ash and embers are all compostable substances. In lower to middle neighbourhoods, colloquial input splitting and remanufacture has long been practised. This has led to the establishment of businesses devoted to the collection, trade, and recycling of items [6].

The literature has established the significance of electricity supply to a country's economic progress. Availability to electricity supply is associated with advances in the areas of human progress, including health insurance, fresh water, youth development, proper hygiene, employment generation, and agricultural production [7, 8]. According to the International Renewable Energy Agency, the helps in increasing for metropolitan trash energy production in 2018 were approximately 11,540 MW (IRENA 2018). There are two fundamental methods for waste heat recovery (i.e., biological and thermal). The physiochemical method relies on the biogas produced as a source of energy from organic waste. During the heat treatment process, however, the waste is converted as refuse-derived gas for ignition, gasifier, or exothermic reactions to generate power, warming, or both [9].

The most commonly employed treatment is combustion (also known as waste-to-energy in this study), which reduces refuse volume by 70% and 90%, respectively [10, 11, 12]. Nigeria is in the grip of an electricity crisis that looks to have no end in sight. The nation's socioeconomic and innovation advancement has been hampered by the electrical deficiency. Nigeria has a declining generation capacity of 11,165.4 MW [13]. According to the Transmission Company of Nigeria (TCN), the most significant amount of energy in Nigeria has ever produced is 5074.70MW, which also represents the greatest power generation the nation has ever used daily, at 109,372MWh.

Although waste-to-energy (WTE) is seen as an appealing waste possible treatment in developed nations like the United States, as well as inadequate, ineffective, and outdated nuclear reactors, a high prevalence of faulty equipment, and a notable lack of long-term gasoline (natural gas) consumption for power utilities Putting in place a waste-to-energy (WTE) scheme that requires another sustainable fuel could be a viable solution to Nigeria's low power generation (solid waste). It is already possible to use solid waste to generate electricity. In Sweden, for example, approximately 5.7 million tonnes of straightened flammable solid waste

were combusted in 33 WTE plants across the country in 2014, producing approximately 16.6 TWh of energy, of which 2.0 TWh was used for electricity and the remaining 14.6 TWh for district heating.
The heat produced from the combustion of this garbage is used to generate steam in the boiler super-heater. The Lagos State Government adopted a policy to produce waste into electricity in order to increase the state's electricity supply. The British government has endorsed enhanced international investment in Lagos State, as structure on the state's first Waste-to- Energy facility begins. This happened when West African ENRG, a foreign energy company, made the announcement plans to invest $150 million in the development of a 25-megawatt waste-to-energy plant capable of processing 2.5 million tonnes of waste energy per day. It has been stated that it is because Lagos generates over 2.5 million tonnes of waste per day, this proposed solution is conceivable [14].
During the administration of Babatunde Raji Fashola, in 2014, Lagos had a policy to such effect. However, the approach in Lagos was hampered by a lack of monitoring and evaluation. Mrs Belinda Odeneye, Permanent Secretary for Environmental Services, and Ibrahim Odumboni, Managing Director of the LAWMA, confirmed that the energy company arrived in Lagos in 2014, had its waste conversion plan unveiled by Governor Babatunde Fashola in 2015, and now plans to set up a waste to energy plant.

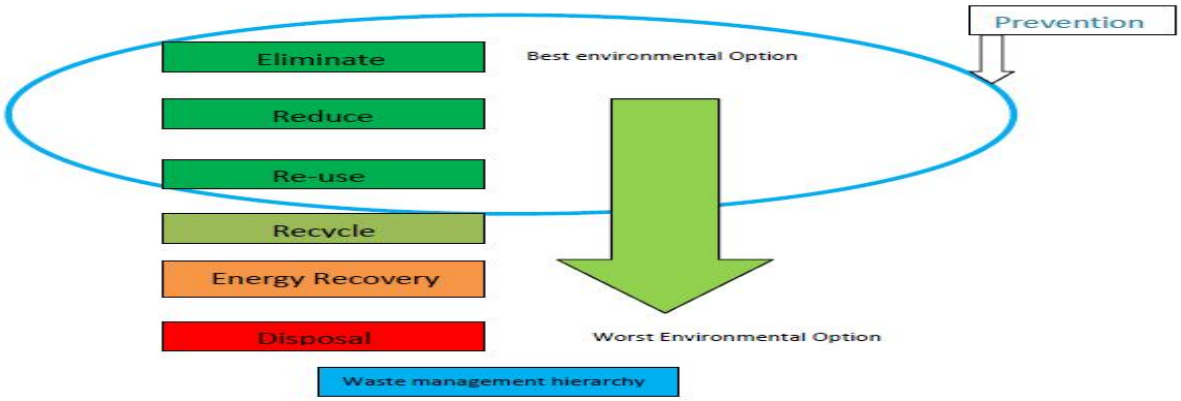

Figure 1. Shows the Waste Management Hierarchy:
Source: Onu, Price, Surendran, Ebie (2012).

In Figure 2.1, the three top concentrations in the waste hierarchy, as defined in the diagram, which are (reduce, reuse, and recycle). This waste hierarchy was designed to show the flow in the waste management to reduce or to aid the transformation of solid waste into new products through recycling to and up-cycling and possibly incineration if implemented. Even when the 3Rs are used to their full potential, a significant amount of generated garbage is said to be managed for incineration. According to the International Renewable Energy Agency, the global capacity for generating electricity from waste was estimated for11, 540 MW in 2018.
Two principal routes are associated with energy recovery from waste. The pathway involves the creation of incineration from solid waste as an energy source [9]. Oxidation process referred to as waste-to-energy in this study is the most suitable heat treatment, with volume of waste lowered by 70% and 90%, respectively [15]. Even though waste-to-energy (WTE) is now considered an appealing choice for waste processing in advanced nations such as the United States, Japan, and the European Union [16], it has a low presence in developing nations. The upgrading of waste disposal systems in low- and moderate-income nations complicating the use of waste to generate energy, as a result, the transiting nations continued to experience challenges in waste control.

Methodology

The demographic for this study was determined using the number of Lagos State Ministry of Pollution prevention And Control; Waste Management Authority (LAWMA) employees; and Lagos State

Environmental Protection Agency employees (LASEPA); PSP within Each Jurisdiction (Local government areas) and the end-users (LCDAs representing each jurisdiction), that is, inhabitants of each selected local governments' areas. The population of the study is therefore illustrated in the table 1.

Table 1. Population Details for Sample Selection

S/N	Ministry	AGENCY Public	Private Sector Partners	END-USERS	STAFF STRENGTH
1	Lagos State Ministry of Environment and Water Resources				300
2		LAWMA			546
3		LASEPA			340
4			Private Sector Participants		318
5				CDAs (57 LG&LCDS)	342
				Total	1846

Sources: LAWMA (2022); LASEPA, (2023)

The Taro Yamane formula was used to subset a whole population (1846). The computation is determined by the formula below:

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

Where:

n= corrected sample size of the study; N = total number of the population; e = merging of errors.

Using Taro Yamane, the study population is calculated thus: $n = \frac{N}{1+N\ (e)2}$

$n = \frac{\mathbf{1846}}{1+\mathbf{1846}\ (0.05)2}$; $n = \frac{\mathbf{1846}}{1+\mathbf{1846}X\ 0.0025}$; $n = \frac{\mathbf{1846}}{5.615}$; n = 328.76 App. 329

Multistage sampling technique was adopted which included cluster stratified and simple random sampling techniques. Cluster sampling is a sort of sampling techniques wherein the investigators partition the people into distinct groups (clusters) to conduct research. The table 2 shows how the selected respondents are grouped using a multistage sampling approach.

Table 2. Sampling technique and distribution of sample size.

S/N	Ministry	AGENCY Public	Private Sector Partners	END-USERS	STAFF STRENGTH	Sample Size of 329 to Shared Among the Respondents
	Lagos State Ministry of Environment and Water Resources				300	$\frac{300}{1846}$ X 329= 53.47
1		LAWMA			546	$\frac{546}{1846}$ X 329= 96.47
2		LASEPA			340	$\frac{340}{1846}$ X 329= 60.59
3			Private Sector Participants		318	$\frac{318}{1846}$ X 329= 56.7
4				CDAs (57 LG&LCDS)	342	$\frac{342}{1846}$ X 329= 60.9
				Total	1846	329

Source: Field Survey, March, 2023.

This study's data collection instruments are a structured questionnaire, key informant interview (KII), and focus group discussion (FGD). The justification for adopting the instruments mentioned above is that since this study adopted a mixed-method (qualitative and quantitative methods), the researcher grouped the targeted respondents based on their relevance in this study. The structured questionnaire was distributed among all staff of the targeted population, the end-users across the board in Lagos State and the employees at various PSPs in Lagos. However, an in-depth interview was granted with the top managers of the LAWMA and LASEPA, respectively. Also, a focused group discussion was held with the selected PSP and LAGRA members in Lagos State. The following are the details on the usage of the instruments.

Results

The unit of analysis in this study are the staff of the Lagos State Ministry of Environment and Water Resources (53), LAWMA employees (97), LASEPA employees (61), and PSP and LAGRA operators (57), all living within the targeted areas in Lagos State. A total of three hundred and twenty-nine (329) copies of the questionnaire were administered. Table 3 presented the responses and retrieval rates of the questionnaire distributed.

Table 3. Questionnaire responses and retrieval rates.

Category of respondents	Sample Size	Returned and used	Retrieval rate	Mean retrieval rate
LAWMA	62	60	96.8%	91.5%
LSME	53	47	88.7%	
PSP	57	47	82.5%	
LASEPA	61	57	93.4%	
LAWMA (ACA)	35	29	82.9%	
Residents	61	61	100.0%	

Source: Field Survey Data (March, 2024)

Statement of Research Hypothesis H_01: Solid waste disposal has no significant effect on environmental hazard in Lagos State, Nigeria;
Independent variable = Solid Waste disposal (Items 3, 4 and 5)
Dependent variable = Environmental hazard (Item 1 and 2)

The regression test results presented in Table 4. displays the coefficient of determination (R^2), which is used to establish the predictive power of the study's model, F-value which establishes the goodness of model fit and the significance of the coefficient of risk reduction strategy with respect to air pollution management.

Table 4. Summary of regression analysis for the solid waste and environmental hazard.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.
1	0.398[a]	0.158	0.155	0.51194	56.230 (1,299)	0.000[b]

Predictors: (Constant), R: Correlation coefficient; R Square: Coefficient of determination; F: F-statistic; Sig.: Significance level; RRS: Research variable/predictor

Coefficient of determination (R^2) value of 0.158 shows that risk reduction strategy explained 15.8% of the variation observed in air pollution management. The remaining 84.2% of the variance observed in air pollution management accounted for variables not used in this study. The overall model significance of regression test (F value) revealed that the model predicted has a good fit; this can be explained by the F-value (56.230) and p-value (0.000) which is statistically significant at 95% confidence interval.

Table 5. Regression coefficients for the impact of RRS on APM.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.876	.167		11.254	.000
	RRS	.428	.057	.398	7.499	.000
a. Dependent Variable: APM						

Hence, the regression model is stated as;
APM = 1.876+ 0.428 RRS …….Eq. (ii)
Where: SWD= solid waste disposal ; EH = environmental hazard

The coefficient for SWD in relation to EH revealed that, at 95% confidence level, SWD ($\beta = 0.428$, $t > 1.96$, $p < 0.05$) is statistically significant, as the p-value is less than 0.05 and the t-value greater than 1.96. Hence, SWD has effect on EH in Lagos State; Nigeria. The result also revealed that a unit change in hazard reduction strategy will lead to a 0.428 increase in solid waste management in Lagos State. Given these results, this study therefore concludes that SWD has significant effect on EH in Lagos State, Nigeria. On the strength of this result ($R^2 = 0.158$, $F_{(1,299)} = 56.23$,$\beta = 0.428$, $t > 1.96$, $p < 0.05$).

Statement of Research Hypothesis H_02: Solid waste management policy do not significantly affect the waste-to-energy initiative in Lagos State, Nigeria.

Independent variable = Solid waste Management Policy (SWMP)
Dependent variable = Waste-to-energy initiative (WtE)

Simple regression analysis was used to examine the effect of monitoring and evaluation on Waste-to-energy initiative. The data used for SWMP (independent variable) and WtE (dependent variable) were generated by computing the mean responses for the items used to assess the respective variables. The regression test results presented in Table 6 displays the coefficient of determination (R^2), which is used to establish the predictive power of the study's model, F-value which establishes the goodness of model fit and the significance of the coefficients of reduce and reuse method with respect to environmental degradation control for each of the location under study.

Table 6. Summary of regression analysis for the effect of waste-to-energy initiative

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.
1	0.497[a]	0.247	0.245	0.48258	98.143 $_{(1,299)}$	0.000[b]

a. Predictors: (Constant), ME

Coefficients of determination (R2) value of 0.247 shows that SWMP explained 24.7% of the variation observed in waste-to-energy initiative. The remaining 75.3% of the variance observed in waste-to-energy is accounted for variables not used in this study. The overall model significance of regression test (F value) revealed that the model predicted has a good fit; this can be explained by the F-value (98.143) and p-value (0.000) which is statistically significant at 95% confidence interval.

Table 7. Regression coefficients for the impact of ME on WTE.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.971	.107		18.434	.000
	ME	.354	.036	.497	9.907	.000

a. Dependent Variable: WTE

Hence, the regression model is stated as;
WTE = 1.971+ 0.354 ME …….Eq. (iii)
Where: WTE= Waste-to-energy
SWMP = Solid waste management policy

The coefficient for SWMP in relation to air pollution management revealed that, at 95% confidence level, SWMP ($\beta = 0.428$, $t > 1.96$, $p < 0.05$) is statistically significant as the p-value is less than 0.05 and the t-value greater than 1.96. Hence, SWMP has significant effect on WtE in Lagos State, Nigeria. The result also revealed that a unit change in SWMP will lead to a 0.354 increase in waste-to-energy in Lagos State. Given these results, this study therefore concludes that SWMP has significant impact WtE in Lagos State, Nigeria. On the strength of this result ($R^2 = 0.247$, $F_{(1,299)} = 98.143$, $\beta = 0.354$, $t > 1.96$, $p < 0.05$).

Qualitative Analyses (KII & FGD)

Theme 1 SWD and EH: The two questions raised in this second research question of the study were 'What strategy has been adopted to reduce environmental hazard and air pollution that is generated from solid waste in Lagos?', 'How often is the participation of residents in solid waste management in Lagos?' However, it was responded to in the following order: Answer1: The Lagos State government has an agency in charge of this. LASEPA and I collaborate regularly, and I believe they are doing an excellent job of controlling environmental hazards. Second answer: **very often.**

Table 8. Summary of responses on theme one (SWD & EH).

Questions	Responses	Participants	Percentage
What strategies been adopted to reduce environmental Impact in Lagos	• Public Education • Public awareness	• 1of2 •	• 50% • 00%
How often is the involvement of the residents in solid waste management	• Very often • Not often	• 1of2 • 0	• 50% • 00%

Source: Field Survey, May, 2024

From the table 8, it was discovered that the interviewees accepted that the strategy that have been adopted to reduce environmental hazard is public education. One of the respondents opined that there was a policy to educate all residents of Lagos State, and this was done through public radio to inform the residents about the risk in improper disposal of waste. He also pointed that anyone caught in such unlawful act will be brought to book. The implication is that only one respondent responded to the questions and agreed on the public education on 50% basis.

FGD: From the above theme, the questions were raised, which are: 'What strategy has been adopted to reduce environmental hazard and air pollution that is generated from solid waste in Lagos?', 'How often is the participation of residents in solid waste management in Lagos? 'In response to the questions,

Response i: LASEPA's responsibilities extend beyond environmental preservation. What we do is work with residents so that if there is a health issue caused by air pollution, we are notified and appropriate measures are implemented (*Personal Communication*).
Response ii: There was a prompt response to the complaint. From the second question: Answer i: to be candid, there cannot be 100% protection against environmental pollution, but we ensure it is regulated to some controllable state (*Personal Communication*).

Table 9. Summary of the responses on theme two (SWD & EH).

Questions	Responses	Participants	Percentage
Strategy adopted to curb environmental pollution	• Public awareness • Education	• 10of 10 • 10of 10	• 100% • 100%
Briefly comment on the Environmental hazard production by the residents. What is the role of LAWMA in curbing this menace?	• Environmental hazard is challenges • Regulation • Education	• 10of 10	• 100%

Source: Field Survey, May, 2024

The interviewees and the participants in the FGD responded in ways that offered insight into the research questions. The first question 'the strategy adopted and environmental pollution' 4 out of the 5 responded to the questions with 80% response. The responses were analysed that public awareness and education of the residents about the danger in improper disposal of waste. However, the pitfalls about the policy strategy are that the policy lacks public awareness. As a result, people, companies and organisation still go by their normal improper disposal of waste in Lagos.
From the second question 'environmental hazard protection: The role of LAWMA', all the five respondents responded to the question which is 100% responses. The role of LAWMA in reducing the environmental pollution from landfill cannot be underestimated. All waste generated can be segregated. The LAWMA should not only regulate, but should involve in the public orientation on ways the residents can properly dispose waste. Respondent ii commented that recycling and up-cycling maintenance helps in reducing environmental pollution. The other three respondents are of the opinion that LAWMA should go back to the policy on waste-to--energy arrangement with foreign investor since 2019 (*Personal Communication*).
Theme 2 SWM Policy and Waste-to-Energy: The theme four of this study was drawn from the forth research question of the study. For the purpose of this section, two significant questions were raised for the key informant interview. These include: "Has there been policy on waste-to-energy innovation in Lagos?', 'How effective is the policy monitoring and evaluation on waste-to-energy in Lagos?'
The responses to the questions raised are discussed as follows: Answer: of course yes. There is a policy on waste to energy. Lagos State government, through the ministry of environment and water resources, has established a policy document of the waste-to-energy initiative to tackle electricity deficiency in Lagos. Answer: We reached a deal with a foreign organisation. They will start working on it soon.

Table 10. Summary of responses on theme four (SWM Policy & WtE).

Questions	Responses	Participants	Percentage
Has there been policy on waste to energy in Lagos?	• Policy Existence • Unknown policy Statement	• 2of2	• 100%
How effective is the policy M&E on the Waste to Energy Initiative in Lagos?	• Effective • Ineffective	• 2of2	• 100%

Source: Field Survey, May, 2024.

The table 10 resented the analysis of the key informant interview conducted. It was discovered that the two interviewees responded to the questions. The interviewees agreed that there is a policy on waste-to-energy in Lagos. It was also agreed on that the monitoring and evaluation policy on waste-to-energy was effective. It was opined that government is currently on the talk with a foreign organization to that effect. The implication of this is that policy existence and effectiveness was analysed.

FGD: The above theme revolved around research question four as stated in the chapter one. The questions in this perspective are: 'What is your perception on waste-to-energy approach for solid waste management in Lagos State?' In your opinion, do you think waste-to-energy approach will solve the problem of waste and electricity in Lagos State? (*Personal communication).*

Response i: The response of one of the respondents in the FGD goes thus: 'there was a policy, but if the government is serious about the policy, they should kick-start the project. I know it involves a lot of funding to commence this. However, there was a policy, which means that the financial implication would have been considered. Apart from the incineration power plant, there was a policy to generate gas emission.' The second respondent gave that the approaches are perfectly good as it will add tremendously to the GDP of Lagos State. The third respondent: 'For me, it is a good approach as peculiar to Lagos electricity supply issues.' The fourth respondent: 'it can serve as a solution to electricity deficiency. The fifth respondent: 'I am sure the residents of Lagos should be able to afford it. Even the electricity they pay for is not regular.

Responses ii: From the second question, the responses were straight without explanation. Yes! It will. Yes! If it is consistent. Yes, it will.

Table 11. Summary of responses on theme four (SWM Policy and Waste-to-Energy).

Questions	**Responses**	**Participants**	**Percentage**
Perception of the waste-to-energy in Lagos State	• Effective • Problem solving	• 10 of 10 • 10of 10	• 100% • 100%
Opinion on whether waste-to-energy will solve electricity issues in Lagos	• Absolutely	• 10of 10	• 100%

Source: *Field Survey, May, 2024*

From the responses in the table 11, it is realised that all the respondents gave responses to the questions raised. For the first question, which was to examine the perception of the respondents on the waste-to-energy approach in Lagos, 100% of the respondent contributed to the question, which means that every of the respondents agreed that solid waste van contributes to the effective electricity supply in Lagos State.

Again, from the second question raised in the table, 100% of the respondent gave opinion that electricity of solid waste can be problem-solving in Lagos State. This means that all the respondents agreed to the above statement.

Table 12. Summary of the hypotheses and qualitative analysis tested.

S/N	Research Questions	Hypotheses	Results	Qualitative Tested	Decision
1	In what way is the hazard reduction strategy affect air pollution management in Lagos, Nigeria?	The risk reduction strategy has no impact on air pollution management in Lagos or the State of Nigeria.	$R^2 = 0.158$, $F_{(1,299)} = 56.23$, $\beta = 0.428$, $t > 1.96$, $p < 0.05$ Rejected Null *(H0)*	LASEPA and LAGRO sensitizes the stakeholders about the policy against air pollution in Lagos State	Risk reduction strategy has significant impact on air pollution management in Lagos State, Nigeria.
2	How does monitoring and evaluation affect the waste-to-energy innovation strategy in Lagos, Nigeria?	Monitoring and evaluation do not affect the waste-to-energy innovation strategy in Lagos, Nigeria.	$R^2 = 0.247$, $F_{(1,299)} = 98.143$, $\beta = 0.354$, $t > 1.96$, $p < 0.05$ Rejected Null (*H0*)	Waste to energy approach is a good start. However, government should look into the cause of delay. However, M&E policy not effective in Lagos State.	Monitoring and evaluation affect the waste-to-energy innovation strategy in Lagos, Nigeria significantly.

Source: Compiled by the Researcher (2024)

Table 12 presented the various results of the four null hypotheses tested; the qualitative data generated from the field, and the decisions of the analyses. The results from the hypotheses were in agreement with the qualitative analyses conducted and the decisions were that all the null hypotheses were rejected.

The regression analysis result, key informant, and FGD for the impact of the Environmental hazard reduction strategy on pollution management in Lagos State, Nigeria established that the risk reduction strategy significantly impacts air pollution management in Lagos State, Nigeria. Conceptually, a risk-reduction strategy should reduce air pollution. A risk reduction strategy mindset will encourage creativity because the burning process emits toxic gases into the environment [17]. Thus, a risk-Sreduction strategy is required for the decline in air pollution. Contrary to the result, he noticed that Lagos lacks an integrated strategy for waste management even though a management system that emphasises waste reduction, recycling, and reuse is the most appropriate [18]. Inappropriate dumping of waste materials forces biodegradable materials to rot and decompose under unhygienic and uncontrolled conditions; this action results in foul-smelling gases released into the atmosphere, resulting in air pollution. These toxic gases cause various diseases, including cancer. Correspondingly, it is revealed that burning hazardous and flammable waste increases the risk of polluting the atmosphere. When dangers like pesticides, batteries containing lead, zinc, cleaning solvents, radioactive materials, and plastics are formed, they produce dioxins and gases. Infrastructural development has become overburdened due to increasing population densities in Lagos State.

Consequently, there is an inadequate sewerage system, and solid waste accumulation that causes health risks. Water-borne diseases such as cholera, enteric fever, typhoid, and other diarrhoeal diseases are spread uncontrollably, and access to potable water is limited in Lagos State, and this has worsened the public healthcare system's burden. [19] Discovered that residents who live less than 200 metres from the dumpsite suffer from malaria, chest pains, cholera, and diarrhoea. Residents whose homes were more than 200 metres away were also affected by the dumpsite's chest pain and odour when the winds were in their direction [20].

The regression analysis result from KII and FGD indicates that the effect of monitoring and evaluation on waste-to-energy in Lagos, Nigeria, is significant. This result implies that monitoring and evaluation significantly affect the waste-to-energy innovation strategy in Lagos, Nigeria. According to the findings of this study, there are excellent prospects for Lagos megacity to meet their electricity demands by implementing sustainable practices, particularly converting trash to energy via landfill solid waste collection [21].

It is crucial to highlight that our study is scenario-based; that is, we performed the analysis to establish how much solid waste might have been generated from landfill waste and how much energy could have been generated. Because capturing equipment is not currently present on these sites, it is difficult to determine how much waste remains that can be caught for energy generation [22].

Conceptually, energy services are the brains behind a country's socioeconomic development, reducing uncertain consequences for business firms[8]. While its ripple effect may offer households and firms the opportunity and potential for growth, the challenges presented by the unpredictability of government policies are of concern because inconsistency in government makes reasonable long-term plans and predictions impossible [23].

This study empirically reveals that monitoring and evaluation significantly affect the waste-to-energy innovation strategy in Lagos, Nigeria. These findings corroborate the submission of IRENA[11, 12]. According to Gohlke & Martin [10], waste-to-energy is the most prevalent thermal treatment, while IRENA (2018) categorically stated that the global capacity for power generation from municipal garbage in 2018 was approximately 11,540 MW [44, 25]. Although the waste-to-energy innovation strategy is widely recognized and is regarded as an attractive option for waste treatment in developed countries, this option is yet to be maximized in Lagos State [24, 25].

Conclusion and Recommendations

From the second objective and the hypothesis tested on environmental hazard reduction strategy and air pollution management in Lagos, the study concluded that hazard reduction strategy has a more significant impact in reducing air pollution in Lagos. The analysis showed that the government had not done enough to capture the aspect of air pollution, and this is why many Lagos environments witnessed hazardous pollution, especially during the rainy season. It is worrisome that Lagos lacks an integrated strategy for waste management, even though a management system that emphasises waste reduction, recycling, and reuse is the most appropriate. The welfare gains from the policy that prevents premature deaths and disease have the potential to be quite large.

From the fourth objective and the result of the hypothesis tested on monitoring and evaluation and its effect on waste-to-energy strategy in Lagos and other states in Nigeria, the analysis concluded that monitoring and evaluation significantly affect the waste-to-energy innovation strategy in Lagos, Nigeria. Empirically, it was found that policy-making on waste-to-energy has not been successful over the years. While its ripple effect may offer households and firms the opportunity and potential for growth, the challenges presented by the unpredictability of government policies are of concern because inconsistency in government makes reasonable long-term plans and predictions impossible. As a result, the following are the recommendations for the study:

Firstly**,** Policymakers should do more to capture or mitigate the air pollution caused by garbage landfills. The government should separate the solid garbage generated by residents (recycled, up-cycled, and other waste), and then the hazardous waste should be appropriately managed to avoid environmental air pollution, which causes diseases and death. Secondly, the government should invest more in converting extremely polluted garbage to energy without endangering inhabitants' health, while others can be replicated or recycled to create more cash for the State. Furthermore, the government should publicly educate residents on proper waste disposal methods. Most of the high-risk trash is created by households and manufacturing firms in the State. The government should ensure that regulations are in place to restrict solid trash generation, and anyone who violates them should be fined. Conclusively**,** the LASEPA should be strengthened, educated, and oriented to do its duties effectively. This agent should be stationed at all times at

Lagos manufacturing plants to check that they are adhering to the Lagos State government's directive on proper trash disposal (avoid disposal of polluted air waste publicly).
The policy on Waste-to-Energy should be revisited for the vision of the Lagos megacity to be realised. Government should re-examine the policy on waste-to-energy from the monitoring and evaluation stage. There should be a policy reconciliation to determine whether to continue the policy or to start all over. Also, Government should give more room for experts and investors that are willing to invest in waste-to-energy in Lagos, since Lagos generates more tonnes of waste, those waste should be utilised to avoid environmental risk.

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