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Moving from Waste Management to Waste Monetization: Delta and Bayelsa States in Perspective

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ABSTRACT

This research examined the possibility of monetizing wastes in Delta and Bayelsa States, Nigeria. The study mirrored the waste management approaches hitherto and therefrom initiated strategies that can be implemented to transform waste into valuable resources while promoting environmental sustainability and economic growth. The study adopted the cross-sectional research design. The Taro Yamane equation was used to determine a study population of 400 respondents. The spearman's rank correlation coefficient was deployed to test the perception of waste monetization in Delta and Bayelsa States. Findings indicated that the locals knew very little about waste monetization. Albeit, they identified that they will be willing to participate in the process if initiated. The perceptions in both States were not significantly different at $p>0.05$. The findings highlighted the importance of adopting innovative waste management practices to harness the untapped potential of wastes in Delta and Bayelsa States.

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Introduction

Waste generation is a pressing global challenge that poses significant environmental, economic, and social impacts. Traditional waste management practices, such as landfilling and incineration, are no longer sustainable in the face of increasing waste volumes and limited resources [1]. However, waste can be seen as a valuable resource that, if properly managed and monetized, can contribute to a more circular economy [2]. Waste monetization refers to the process of converting waste materials into valuable products or services, thus creating economic value from what was previously considered as a burden [3]. It involves innovative strategies and technologies that enable the extraction, transformation, and commercialization of waste materials to generate revenue streams and reduce waste disposal costs [1].

The concept of waste monetization aligns with the principles of the circular economy, which aims to minimize waste generation and maximize resource efficiency. In this regard, waste monetization offers a sustainable and economically viable approach to managing waste while simultaneously reducing environmental impacts [4]. However, there are various approaches to waste monetization, each with its own benefits and challenges. One common strategy is recycling, which involves transforming waste materials into new products or raw materials. Recycling not only conserves resources but also reduces the demand for virgin materials, thereby minimizing environmental degradation associated with extraction and manufacturing processes [5]. Another approach to waste monetization is the conversion of organic waste into energy through anaerobic digestion or composting. This process generates biogas, a renewable energy source, and produces nutrient-rich compost, which can be used in agriculture. Recycling organic waste may be channeled to energy generation and sustainability, thus waste monetization may contributes to renewable energy production and reduce greenhouse gas emissions [5].

Furthermore, waste-to-energy technologies, such as incineration and gasification, offer opportunities for waste monetization by converting waste into heat or electricity. These technologies help reduce reliance on fossil fuels, contribute to energy diversification, and provide a viable solution for waste management in areas with limited landfill space. Additionally, waste monetization can also involve the recovery of valuable materials from waste streams [1]. A case in point is the extraction of metals from electronic waste or the recovery of rare earth elements from discarded products which provides economic opportunities while reducing the need for resource-intensive mining operations [4].

The transition towards waste monetization requires collaboration between governments, industries, and the public. Policymakers play a crucial role in creating an enabling environment through regulations, incentives, and supportive frameworks that promote

waste monetization initiatives. Also relevant is, industry stakeholders need to invest in research and development to foster technological advancements and innovation in waste management [5]. While this has been successful in the West, Africa in general and Nigeria in particular has not made much progress in this area. As such waste management is a huge burden.

Several successful waste monetization projects have been implemented worldwide, which demonstrates the feasibility and benefits of adopting such approaches. The Scandinavian countries can be mentioned in this regard and have made significant progress in waste-to-energy systems, with some achieving near-zero landfilling [6]. Similarly, countries like Germany and Japan have implemented comprehensive recycling programs, showcasing the economic and environmental advantages of waste monetization [7].

Waste monetization offers a promising pathway towards sustainable waste management by transforming waste into valuable resources. These innovative strategies and technologies prove that waste can be harnessed to generate economic value, conserve resources, and reduce environmental impacts. The transition towards waste monetization requires collaborative efforts, supportive policies, and investments in research and development. Through waste monetization, we can move closer to a circular economy where waste is no longer considered a burden but rather an opportunity for economic growth and environmental stewardship.

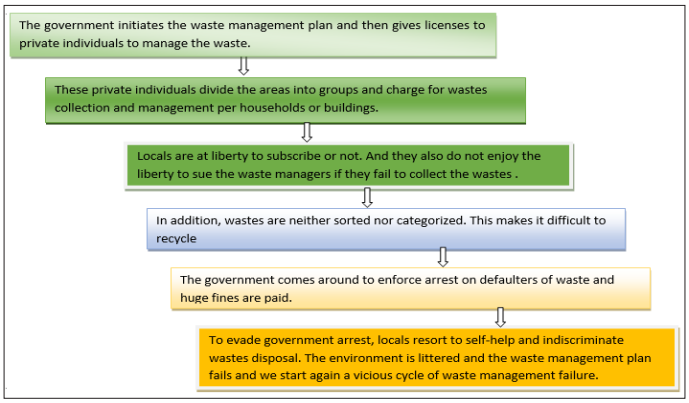

Figure 1: Typical Waste Management Plan in Delta and Bayelsa States

Source: Authors conceptualization of the realities of waste management in Delta and Bayelsa States.

In Delta and Bayelsa states waste generation (especially domestic waste) has become a serious environmental challenge [8]. Government emphasis has been on the collection and crude disposal of generated wastes (see figure 1). These efforts have been ineffective for two reasons; a) not everyone can afford the cost required by the waste managers, b) locals hardy know anything about waste handling and management, therefore simple waste management approaches such as waste sorting is not practiced. Therefore wastes are lumped together and which makes it difficult to manage. There have been several attempts made by researchers to find ways of managing wastes, these attempts have either been on waste management practices, evaluating waste volumes, or assessing the health effects of domestic wastes; with little or scant attention paid to the monetization of domestic wastes [9-11]. It is the opinion of the authors that monetizing waste is a step that government and locals in Delta and Bayelsa states should try in a bid to eradicate waste management challenges. Therefore, this study assessed the waste monetization potentials in Delta and Bayelsa States.

Literature Review

Waste monetization is a concept that aims to convert waste materials into valuable resources, thereby creating economic value while addressing environmental challenges. This literature review provides an overview of the existing literature on waste monetization, including its principles, strategies, challenges, and potential benefits. By synthesizing key findings from relevant studies, we can gain insights into the current state of knowledge and identify areas for future research and practical implementation.

According to central to waste monetization is the principle of the circular economy [12]. The circular economy framework emphasizes the need to move away from the linear "take-make-dispose" model and instead promote a closed-loop system where waste is considered a valuable resource. Waste monetization aligns with this principle by viewing waste as a potential source of economic value and encouraging the recovery, reuse, and recycling of materials.

Advanced that a variety of strategies and technologies can be employed to effectively monetize waste. Recycling is a widely adopted approach, involving the conversion of waste materials into new products or raw materials [13]. Recycling not only reduces waste and conserves resources but also contributes to energy savings and reduced greenhouse gas emissions. Another strategy for waste monetization is the conversion of organic waste into energy. Technologies such as anaerobic digestion and composting enable the transformation of organic waste into biogas, a renewable energy source, and nutrient-rich compost. This approach not only provides an alternative energy source but also addresses the challenges of organic waste management and reduces environmental impacts.

They also advanced that waste-to-energy technologies, such as incineration and gasification, offer additional opportunities for waste monetization [13]. These processes convert waste into heat or electricity, reducing the reliance on fossil fuels and providing a sustainable solution for waste management. However, these technologies must be implemented with proper environmental controls to minimize potential negative impacts. The recovery of valuable materials from waste streams is another important strategy for waste monetization. Techniques such as mechanical sorting, chemical extraction, and biotechnological processes enable the extraction of valuable metals, rare earth elements, and other resources from waste. This not only reduces the need for resource-intensive mining but also presents economic opportunities through the sale and reuse of these materials [14].

While waste monetization holds significant potential, there are several challenges that need to be addressed. According to these challenges include technological limitations, infrastructure requirements, policy and regulatory frameworks, and public perception and awareness [15]. Technological advancements are necessary to improve the efficiency and effectiveness of waste monetization processes, particularly in the recovery of valuable materials from complex waste streams. Infrastructure development is crucial to support waste monetization initiatives. Adequate facilities for waste collection, sorting, treatment, and recycling are needed to enable effective waste management. Additionally, supportive policy and regulatory frameworks that promote waste monetization and incentivize the adoption of sustainable practices are essential.

Averred that the public perception and awareness play a vital role in waste monetization [16]. Education and outreach programs

are needed to inform and engage the public in waste reduction, recycling, and the benefits of waste monetization. Building trust and demonstrating the economic and environmental advantages of waste monetization can help overcome resistance and scepticism.

However, there are potential benefits of waste monetization. Waste monetization offers numerous potential benefits, both from an environmental and economic perspective. By reducing waste generation and promoting resource efficiency, waste monetization contributes to environmental sustainability. It helps minimize waste disposal in landfills, reduces greenhouse gas emissions, conserves natural resources, and mitigates environmental pollution [13].

From an economic standpoint, suggested that waste monetization presents opportunities for job creation, economic growth, and innovation [12]. The monetization of waste can lead to the development of new markets, industries, and entrepreneurial ventures. The recycling industry, in particular, has the potential to generate significant economic benefits through job creation, revenue generation, and cost savings. Moreover, waste monetization can result in cost savings for waste management. By implementing efficient waste management systems, including recycling and waste-to-energy technologies, the costs associated with waste collection, transportation, and disposal can be reduced. This can free up financial resources for other important societal needs.

Materials and Method

Study Area

Delta and Bayelsa are neighboring states located in the Niger Delta region of Nigeria. These states are of particular interest due to their unique geographical features, diverse economic activities, and significant waste management challenges (See figure 2).

Delta State is situated in the south-South geopolitical zone of Nigeria, bounded by Edo State to the north and east, Ondo State to the northeast, Rivers State to the southeast, and the Bight of Benin to the south. Bayelsa State, on the other hand, is located to the south of Delta State and is bordered by Rivers State to the east and southwest and the Atlantic Ocean to the south.

The region is characterized by a network of creeks, rivers, and swamps, making it a major delta region [17]. The Niger River, one of Africa's longest rivers, traverses through these states, forming an extensive network of waterways that are vital for transportation and economic activities. The diverse topography of the region, including mangrove forests, wetlands, and estuaries, contributes to its ecological significance [18].

Delta and Bayelsa States experience a tropical rainforest climate characterized by high temperatures (mean temperature of 290C) and heavy rainfall throughout the year. The average annual rainfall ranges between 2,000 and 3,000mm, with the wettest months typically occurring between April and September. The region is also prone to flooding due to its low-lying topography and proximity to water bodies. This also makes poor waste management a major concern for health in the area [19].

The Niger Delta region, including Delta and Bayelsa States, is known for its rich natural resources, particularly petroleum and gas deposits. The oil and gas industry plays a significant role in the economic activities of these states, contributing to Nigeria's overall oil production. The presence of oil companies has led to the establishment of oil refineries (which are not working currently), petrochemical industries, and other related services. In addition to the oil and gas sector, agriculture is an important economic activity in both states. Delta State is known for its agricultural productivity, with a focus on crops such as oil palm, rubber, cocoa, and cassava. Bayelsa State, although relatively smaller in size, also engages in agricultural activities, including fishing, farming, and aquaculture.

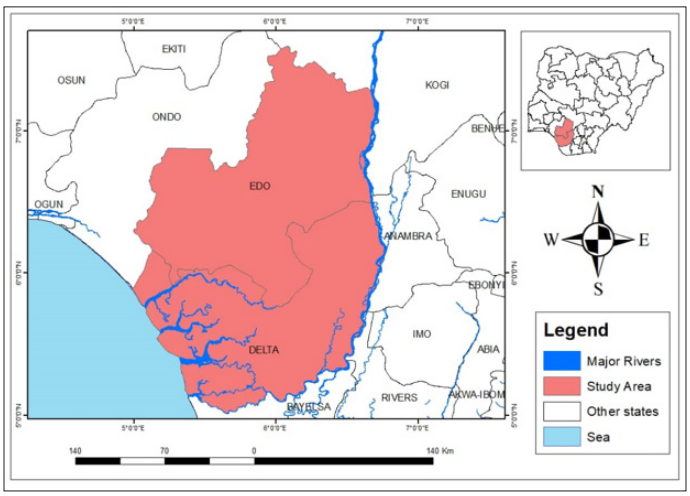

Figure 2: A section of the Niger Delta Area indicating the Study area for this study.
Source: modified after Federal Ministry of Lands, Housing and Urban Development (2008)

Despite the economic activities and natural resources in Delta and Bayelsa States, waste management poses significant challenges in the region. Rapid urbanization, population growth, and industrial activities have led to increased waste generation, which has not been adequately addressed [20].

One of the primary waste management challenges is the inadequate infrastructure and facilities for waste collection, treatment, and disposal. The lack of proper waste management systems results in open dumping, burning of waste, and the indiscriminate disposal of waste into water bodies, and leading to environmental pollution and health risks [21]. The proximity of the states to the Niger Delta region further exacerbates the waste management challenges. Oil spillage and other pollution incidents in the region have contaminated land and water resources, making waste management even more complex. The cleanup and remediation of oil-polluted areas require concerted efforts and specialized technologies.

Moreover, the impact of climate change, including increased rainfall and flooding, poses additional challenges to waste management. Flooding events often result in the discharge of untreated waste into water bodies, exacerbating pollution and public health risks [22].

To address these waste management challenges, there is a need for comprehensive waste management strategies that prioritize waste reduction, recycling, and the establishment of proper waste treatment and disposal facilities [23]. Collaboration between the government, private sector, and local communities is essential for implementing sustainable waste management practices and raising awareness about the importance of waste reduction and recycling through monetization of wastes.

Methodology

The study adopted the cross-sectional research design. The benefit of a cross-sectional study design is that it allowed the researchers to compare many different variables at the same time in this study. The investigation of waste monetization in Delta and Bayelsa states required a quantitative approach [24]. To proceed with the study the researchers classified the study area into income categories and a total of 3 classes were derived for each state. These included the low medium and high-income earning groups. After this was done the population of each state was divided by the house hold size expectancy (5) to determine the target households. This brought the target population (households) for Delta and Bayelsa states to 1127220 and 558146.2 respectively. This population was thus further reduced to a sizable one with the aid of the Taro Yamane equation (see equation 1)

$n = N/ 1+ N(e)^2$……. equ (1)

where: n is the sample size
1 is a constant
e is the error term (0.05)

The total population for the study came to 399.9 same as 400. This means that the 400 households were to be interrogated on issues surrounding waste monetization in the study area. However this population was proportionally split among the states using their earlier determined household sizes. Thus, Delta had 268 households and Bayelsa got 132 households. The designed questionnaire was modified after Famous and distributed using the random sampling techniques [25]. The inclusive criteria were head of households or any one available of ages 18 and above; individuals that could communicate in English and understood waste management to a lesser or greater extent [26].

The validation and test for reliability of the instrument was done using face and content validity and the test re-test methods [27]. The PPMC was deployed to correlate a twin test using same instrument on respondents within a two weeks interval. The r value realized was 0.93. This made the researchers have confidence on the instrument and to distribute the instruments in the field.

The data were presented in tables and statistical diagrams. SPSS was used to analyze the data. This software enabled the researcher to deploy the spearman's rank correlation coefficient to test the perception of waste monetization in Delta and Bayelsa States.

Results and Discussions

Table 1 presented the demographic statistics of the respondents. The male therein were 72.3% of the total respondents while the females made up the balance of 27.7%. The age distribution of the respondents showed that the respondents were mostly above 34 years (59.5%). The table also shows that there are more low income earners and comprised of 60.8% of the total respondents; and the medium income earners represented 28.8%; while only 10.5% of the population agreed they belonged to the high income earning class.

Table 1: Basic Bio Stats of the Respondents

Demographic characteristics	Options	Frequency	Percentages (%)
Sex	Male	289	72.3
	Female	111	27.7
Total	Total	400	100
Ages	18-25	59	14.8
	26-34	103	25.8
	Above 34	238	59.5
Total	Total	400	100
Income categories	High	42	10.5
	Medium	115	28.8
	Low	243	60.8
Total	Total	400	100
Employment type	Self	187	46.8
	Privately employed	165	41.3
	Public servant	48	12.0
Total	Total	400	100

This could imply that there are a lot of persons who may want to get employed in the waste management plan if properly explained to and guided. Again, Table 1 showed that most of the respondents are self-employed with 46.8%. Those who are engaged by private firms represent 41.3% and only 12% of the respondents were employed by the government. It therefore follows logically, that the larger proportion of the locals would have the time to engage in waste management with benefit (getting paid while managing waste).

Table 2: Waste Management Practice

Options	Frequency	Percentage (%)
Open dump	115	28.8
Dump during rains	102	25.5
Incineration	92	23.0
Recycle	54	13.5
Pay waste managers	37	9.3
Total	400	100

The study inquired about the waste management techniques of the respondents. The result of this inquiry was presented in table 2. It was interesting to find that in 2022 very many locals still managed waste by open dump (28.8%) and dumping during rains (25.5%). These practices not only depreciate environmental quality, they also affect the water channels and drainage systems, thus breeding insects of which mosquitoes is more. These lead to diseases and in some cases even deaths [28,29]. Again, 23% of the respondents averred that they disposed waste by incineration. Surprisingly only 13.5% applied recycling to their waste and 9.3% paid waste collectors to help manage their wastes.

Table 3: Knowledge of Waste Monetization

Options	Frequency	Percentage (%)
Yes	56	14
No	344	86
Total	400	100

Table 3 inquired about the awareness of the respondents regarding waste monetization. In the table, only 144% of the respondents knew about waste monetization; while 86% knew nothing about waste monetization. At the explanation of what waste monetization meant in table 4, 76.6% of the respondents indicated that there was waste monetization opportunities in the region and 23.4% of the respondents disagreed. This shows that the respondents agree that there is opportunity for waste monetization in the study area. This finding agrees with that of [25,30] who established similar perception in their studies.

Table 4: Waste Monetization Opportunities in the Region

Options	Frequency	Percentage (%)
Strongly agree	159	39.8
Agree	147	36.8
Disagree	86	21.4
Strongly disagree	08	2
Total	400	100

Table 5: Acceptance of Money in Exchange for Waste

Options	Frequency	Percentage (%)
Yes	369	92.2
No	31	7.8
Total	400	100

In Table 5 the respondents were then asked if they were willing to accept money in exchange for waste. A greater proportion of the respondents indicated that they will be willing to exchange money for waste. This conclusion is based on the fact that 92.2% of the respondents answered in the affirmative. Only 7.8% of the respondents said they won't accept money for waste. Either ways, it is evident that the waste management issues in the region would be easily managed if waste is monetized. This finding agrees with that of [31].

Table 6: Effective Implementation of Waste Monetization Opportunities in the Region

Options	Frequency	Of Total (400)	Percentage (%)
Train locals on ways to manage waste	362	400	90.5
Implement payment systems for waste generated and properly sorted	249	400	62.3
Accredit and train waste managers	287	400	71.8
Build recycling plants for waste management	369	400	92.3
Engage in awareness campaigns for waste management using social, print and Television medias	380	400	95

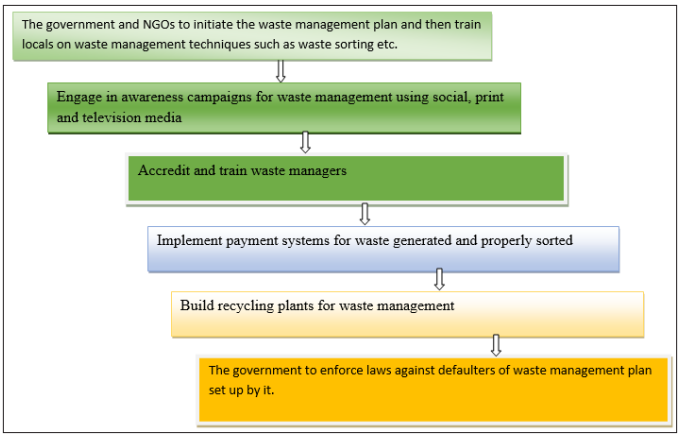

Figure 3: Waste management plan designed by the researchers in line with the findings of this study (See Table 6).

Table 6 inquired from the respondents about their opinion on the best option(s) to adopt to achieve waste monetization in the study area (see figure 3). The respondents therefore suggested the following: train locals on ways to manage waste (90.5%), implement payment systems for waste generated and properly sorted (62.5%); accredit and train waste managers (71.8%); build recycling plants for waste management (92.3%); engage in awareness campaigns for waste management using social, print and television medias (95%).

Table 7: The Importance of Adopting Innovative Waste Management Practices in Delta and Bayelsa States

Options	Frequency	Total	Percentage (%)
Eradication of street side waste dumps	321	400	80.3
Source of employment	279	400	69.8
Limit need for enforcement against waste pollution	249	400	62.3
Reduce environmental and health hazards associated with domestic waste	357	400	89.3

Table 7 inquired from the respondents about their opinion on the importance of adopting innovative waste management practices and what effect(s) it will have on waste management in Delta and Bayelsa States. The respondents therefore suggested that if waste monetization is adopted, then the following are expected to happen: Eradication of street side waste dumps (80.3%); Source of employment (69.8%); Limit need for enforcement against waste pollution (62.3%); Reduce environmental and health hazards associated with domestic waste (89.3%). These Assertions agrees with those of who suggested same in their studies [25,32].

Table 8: The Relationships in Perception of Waste Monetization in Bayelsa and Delta States

Correlations

		Bayelsa	Delta
Spearman's rho	Correlation coefficients	1.000	.892**
	Sig. (2-tailled)		.000
	N	400	400

**correlation is significant at the 0.01 level (2-tailed)

Table 8 revealed the relationship in the perception of the waste monetization between respondents in Delta and Bayelsa states. The model in the table indicates that we have reached significance at p (.000) < 0.05, r=.892. This implies that there is a significant relationship in the perception of respondents on waste monetization in both Bayelsa and Delta States. The magnitude of the r value indicates strong positive correlation and a coefficient of determination of 0.80. This indicates that 80% of the perception on waste monetization in Bayelsa State can be explained in Delta State, thus, revealing a semblance in the factors of waste and approval of the new management option.

Conclusion and Recommendations

This study assessed the possibilities of waste monetization in Delta and Bayelsa States. The intention of the study was to find a subtle means of managing waste and in effect making both parties (the waste managers and the locals) happy. The intention herein is to create a symbiotic relationship using the force of economics and by it waste is managed. The study deployed the cross-sectional research design and questionnaire was used to harvest data from residents in study area. The summary of the findings of the study are presented in the following paragraphs.

The study inquired about the waste management techniques of the respondents and found that many locals still managed waste by open dump and dumping during rains. These practices not only depreciate environmental quality, they also affect the water channels and drainage systems, thus breeding insects of which mosquitoes is more. These lead to diseases and in some cases even deaths [28,29]. The respondents also disposed waste by incineration; while a few applied recycling to their waste. However, the information on waste monetization was very low among the respondents. Very few knew about waste monetization.

When the respondents were explained to, what waste monetization meant, they indicated that there is a huge opportunity for waste monetization in the area. already adduced that waste monetization is the way to go if total waste management was in the heart of waste managers especially in the developing countries where poverty and diseases are rampant [25,30]. Interestingly, the respondents were willing to accept money in exchange for their wastes thus, confirming the arguments of who adduced that waste monetization wont only manage waste in the their world, but would also be a source of employment to many [31].

On the issue of the best option(s) to adopt to achieve waste monetization, respondents suggested to train locals on ways to manage waste, implement payment systems for waste generated and properly sorted; accredit and train waste managers; build recycling plants for waste management; engage in awareness campaigns for waste management using social, print and television medias.

According to the locals the application of waste monetization would yield eradication of street side waste dumps; source of employment; limit need for enforcement against waste pollution; reduce environmental and health hazards associated with domestic waste. These assertions agree with those of Famous and who suggested same in their studies [25,32].

This study did not attempt waste volume determinations, types nor sources, all of which fell outside of this current research scope. These are as such proposed to be follow up to this study. Nevertheless, the findings of the current study points to the fact that the respondents are willing to monetize waste and even participate in the process. The findings highlight the importance of adopting innovative waste management practices to harness the untapped potential of waste in Delta and Bayelsa States.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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