Journal of Geoscience and Environment Protection, 2025, 13(4), 310-326
https://www.scirp.org/journal/gep
ISSN Online: 2327-4344
ISSN Print: 2327-4336

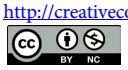
Governance Gaps in Economic Valuation of Solid Wastes for Environmental Sustainability in Kisii Town

Naftal O. Mecheo[1*], Bessy Kathambi[2], James Moronge[2]

[1]University of Nairobi, Nairobi, Kenya
[2]Department of Earth and Climate Sciences, University of Nairobi, Nairobi, Kenya
Email: *mecheonaftal@gmail.com

How to cite this paper: Mecheo, N. O., Kathambi, B., & Moronge, J. (2025) Governance Gaps in Economic Valuation of Solid Wastes for Environmental Sustainability in Kisii Town. *Journal*, *13*, 310-326.
https://doi.org/10.4236/gep.2025.134017

Received: June 29, 2024
Accepted: April 19, 2025
Published: April 22, 2025



Abstract

Solid waste management (SWM) is a major challenge in many urban areas in developing countries. The governance structures in the management of solid wastes are overwhelmed to sustainably manage the solid wastes. The study sought to evaluate the governance gaps in economic prospects for sustainable solid waste management in Kisii town. Study adopted zero-waste and the circular economy theories and a cross-sectional research design. Data collection methods encompassed questionnaires and interviews using KOBO software. Data from interviews was analyzed using both descriptive and inferential analysis. The results indicate that 98% of the residents perceive waste as a resource. Further, results show that only 10% of residents have an acquaintance of Kisii county laws on economic recovery. Governance breaches were depicted that waste recovery takes place at 1.4%, enforcement is at 14.8%, personnel training at 20.4%, and on-source separation of wastes at 17%. This confines economic valuation of waste. The results also indicate that there is at duplicity of players overriding waste with five sectors. There existed few waste-to-resource activities in Kisii town which mainstreamed by the County government could spur the economy of the town. Study recommends that both the county and national governments prioritize mainstreaming solid waste economic recovery by sensitizing people to the value of SWs.

Keywords

Governance Gaps, Economic Valuation, Solid Wastes, Circular Economy Environmental Sustainability

1. Introduction

Solid waste management (SWM) has been and is a main hindrance to sustainable

urban development in many cities/towns worldwide (Adebayo & Bin Ismail, 2016; Andole, 2016; Aryampa et al., 2019; Awasthi et al., 2019; Gupta & Goel, 2021; Un-Habitat, 2010). The burden of governance and managing solid waste particularly in developing countries is made worse by the ever-increasing population, the urbanization process and economic development which consequently increase solid waste generation in urban areas (Kanda & Cherono, 2020). The drain of ensuring operative and sustainable SWM systems is crucial to the attainment of SDGs, especially Goal 11 which aims to make cities sustainable cities (Ogutu et al., 2020). In today's scenario, effective and sustainable management of waste has become extremely challenging in different economies due to the varying proportions and composition of waste (Anokye et al., 2023).

Globally, waste generation is reduced through smart product design and an industrial process in which materials are constantly cycled in a "closed-loop system". A circular economy can reduce the destruction of the environment throughout the system and increase the generation of new added value (Ryota, 2024). The management of solid wastes (SWs) is a global concern and a greater challenge for the sustainable existence of developing countries which face a lot a considerable amount of this waste (Kamil & Abood, 2021). There is a lack of human capital at both the national and local governments and the private sector with the technical expertise necessary for SWM planning and implementation. It has also been noted that officers in charge of waste management have little or no technical background or training (Nolasco et al., 2020).

The governance structures of developing countries have failed to adapt sustainable and economically viable technologies to manage SWs and spur economic growth in their urban areas (Ighravwea & Edemb, 2020). On paper, most developing countries have succeeded in drafting policies that will ensure a clean and green environment. However, there is often a lack of willpower to enforce those laws and policies; and often compromise the system by collecting bribes from defaulters (Ighravwea & Edemb, 2020). The Millennium Development Goals (MDGs) especially goal number seven of promoting environmental sustainability which were to be achieved by 2015 were not operationalized in many developing countries. This governance gap led to the formulation and development of the Sustainable Development Goals (Haregu et al., 2017). The Sustainable Development Goals (SDGs) whose implementation period is to elapse by 2030 are still a mirage in many developing countries (Ogutu et al., 2019). With the economic crisis brought about by COVID-19 and the development consciousness of "economic development first environment later" as Kuznets asserts the country is plunging into an environmental crisis (Rodic et al., 2010). The SDG goals 8, 11, 13, and 15 which aim at making urban areas and all human residences harmless, promoting sustainable economic growth, and protecting ecosystems for sustainability are challenged by the policies and governance in implementing those policies rendering the goals unattainable by 2030 (Kanda and Cherono, 2020). That global partnerships in higher education should be used as a vehicle through which the SDGs

are addressed.

Sustainable management of SWs remains a thorny issue for many African urban centers (Adebayo & Bin Ismail, 2016). Poor SWM practices, especially the use of open dumpsites, and dumping in water bodies, quarries, roads and pathways has escalated the problem of poor hygiene in the continent (Manteaw & Boachie, 2019). The gap that exists between waste regulations, policy, legislation and actual practices is broadening because of limited urban areas capacity including lack of waste management equipment for varied wastes. Solving this gap in urban areas requires major interventions, technological investments and know-how (Un-Habitat, 2010). Enough attention is not given to SWM in Sub-Saharan African countries. Further, he adds that major constraints facing SWM in Sub-Saharan Africa include the lack of technical expertise, finance, low investment in infrastructure, wrong attitude towards solid waste disposal and lack of the needed political will. SWM is given very low priority in the budget due to limited finances resulting in very limited funds being provided to the SWM sector by the governments (Orhorhoro & Oghoghorie, 2019).

In Kenya, the constitution provides a right to a clean and healthy environment under Article 42 to all individuals in the present and future generations. Articles 69 and 70 stipulate the obligations to environmental protection, conservation, and management to enable development that is conscious of the present and future use of natural resources (COK, 2010). However, this right and its obligation currently is good on paper and to those who have knowledge about it and can be able to demand it in case it is infringed.

Kenya has made significant progress in waste management through the enactment of legislations and policies, the most recent being the National Sustainable Waste Management Act 2022, the National Sustainable Waste Management Policy, 2021 and the Extended Producer Responsibility (2021) Regulations (Haregu et al., 2017) which are calling for more sustainable waste management. In addition, while counties are supposed to enact laws and policies around waste management, most of them still lag in the realization of these regulatory frameworks (The Kisii County Solid Waste Management Act, 2015). Kenya has the potential to transform its economy through plastic circularity by aligning its policies and legislations around plastics, both at the National government and County government levels (Anomat & Ibrahim, 2022).

In Kisii town, the residents in cities are not empowered to enforce the policies and regulations of SWM (Ogutu et al., 2019, 2020). Collaboration among institutions is limited in waste management, equity, public participation, transparency, accountability, corruption and non-conformity to the rule of law are among the major setbacks of SWM in Kisii (Ochieng, 2016) critiques. The current policies, laws, and regulations are unable to make an impact since they are on the national sphere and have not been adopted and enacted by the county assemblies for reinforcement (Oluoko & Mutisya, 2019). Therefore, the current waste management practices, waste management inadequacy, and inferring the Circular Economy as

a solution for successful waste management practices are also discussed (Kamble, 2022). From this literature, it's evident that there exist governance gaps in policies, and legal and institutional frameworks that will foster sustainable SWM in the country. This study therefore sought to evaluate the governance gap in economic prospects for sustainable SWM in Kisii town-Kenya and other developing countries.

2. Materials and Methods

The study was carried out at Kisii town which lies in Kisii County, Kenya (**Figure 1**). The town currently serves as the county headquarters of Kisii County. It covers 8 km^2 and it has recently sprawled to extend its boundaries by 29 km^2, a total of 37 km^2. The town's siting on highlands enhances the growth of varied vegetation cover enabling the hinterland to produce a lot of food crops and vegetation GOK (2021). The area majorly receives orographic/relief rainfall all year round, with two maxima in April and October. Kisii town mainly consists of volcanic soils which favor the cultivation of cash and food crops. As of 2019, the town had a population of 112,417 (KNBS, 2019) making it the second most populous town in Nyanza region after Kisumu city. The town is the eighth most populous town in Kenya. Among Kenya's urban areas, Kisii town has a relatively high population density of 2862 persons per km^2 (KNBS, 2019). Kisii town is among the most densely populated areas in Kenya after the two cities of Nairobi and Mombasa. The economy of the town currently is obtained from bustling business activities and agriculture. Currently, the town is the fastest growing in Western Kenya.

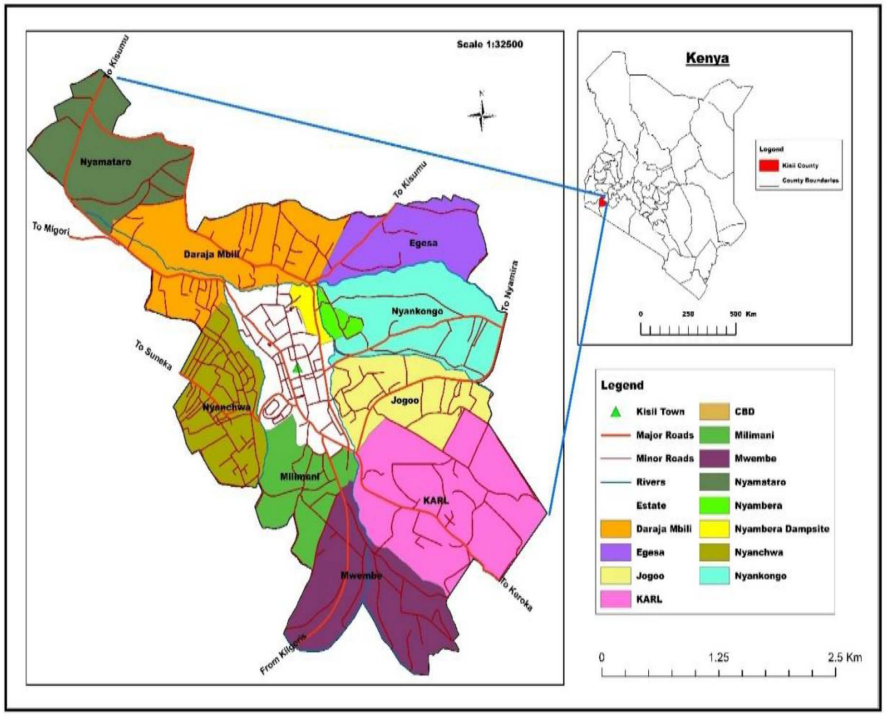


Figure 1. Map of Kisii Municipality. Source: Kisii Topographical Sheet 130/2 G.O.K (2021).

This research adopted a cross-sectional research design where the variables were observed and analyzed how solid wastes can be economically spurring sustainable waste management. Both qualitative and quantitative methods were used. This research employed purposive and random sampling. Purposive sampling guided the selection of nth governance focus groups dealing with the management and disposal of solid wastes. Random sampling was used to sample the staff working on the various sectors of SWM in Kisii town. The study targeted the governance of SW in Kisii town. Focus groups dealing with the management of solid wastes formed the sample size. Using Yamane's formula: $n = N/1 + N(e)^2$, the following sample size was determined as shown in Table 1.

Table 1. Sampling criteria showing the sample size.

Target Population/Focus group	Number of Staff	Sample Size
NEMA Kisii office	4	2
CEC and CO Environment	2	2
Directorate Environment	4	2
Directorate public Health (WM)	8	3
Directorate Municipality	10	4
SWM Staff	175	64
Private Organizations Collection	8	3
Private Organizations Recovery	2	2
TOTAL Total	201	82

The research was guided by "The Zero Waste Theory" by Upadhyaya (2013) which asserts that better waste management systems along with technology will enable zero and sustainable waste management with economic prospects. This will enable the development and adoption of the best policies, principles, and practices to enable the minimization of the effects of waste to the lowest (Hannon & Zaman, 2018). Further, the research was directed by "The Circular waste theory" Propounded by Boulding (2010), which supports a regenerative (circular) approach in the management of natural resources, in contrast to a linear approach which propagates damaging and depletion of these natural resources limiting the presence and use of fixed natural resources for development leading to environmental degradation (Sadeghi et al., 2021).

Data was collected using primary data collection such as questionnaires, use of Key Informant Interviews, and observation (Creswell, 2014). Using ODK data was collected from the sample size. Questionnaires and focus group interviews were the preferred data collection tool for the three objectives. Questionnaires were useful in collecting data from waste management officers and SWM staff. Interview schedules were used for the SWM and governance officials. Data from interviews were analyzed descriptively and percentages and charts were used to present the results. Data obtained from questionnaires was coded and analyzed using Statistical Package for Social Science (SPSS), KOBO, and Excel spreadsheets. These results are presented using

bar graphs, tables, pie charts, Pearson Chi-Square tables, and proportional circles.

3. Results

3.1. Governance Gaps in Economic Valuation of Solid Wastes

3.1.1. Perception of the Economic Value of Waste

According to the findings, most respondents 98% believe waste has economic value, with only a small fraction holding a contrary opinion as seen in Figure 2.

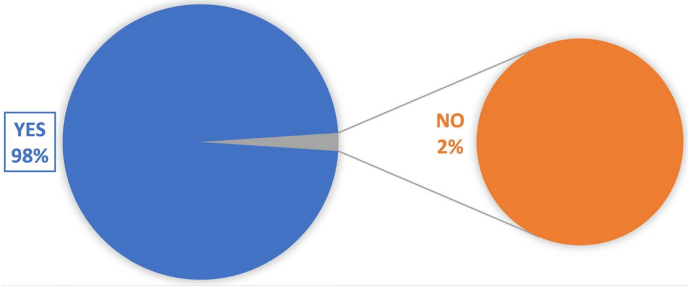


Figure 2. The participant's perception of the economic value of waste.

The results indicate that the majority of the respondents, 98%, perceive waste as a resource while a paltry 2% do not perceive waste as a resource. The gap exists on how to transform the waste into income-generating activities (IGAs).

3.1.2. Knowledge of County Laws That Support the Economic Valuation of Solid Wastes in Kisii Town

A small number of interviewees 10% stated that they were aware of Kisii County legislation that supports the economic value of garbage.

However, many of the participants, who also happen to work in the solid waste management sector, were noticeably uninformed of any rules implemented by Kisii County to encourage the economic value of solid waste (Figure 3).

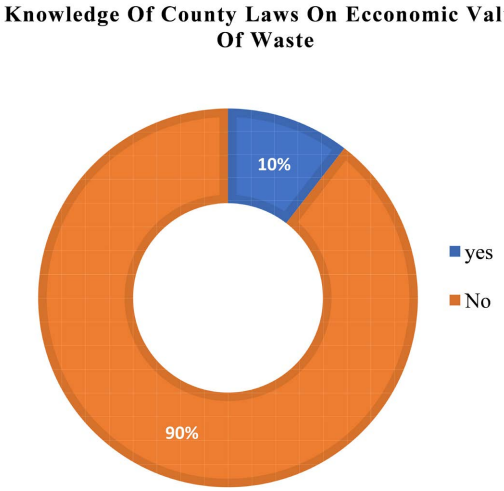


Figure 3. Participants' knowledge of Kisii County laws supporting the economic value of waste.

3.1.3. Enforcement of Laws in Kisii Town on Solid Waste for Economic Valuation

In this section, the research sought to establish the extent of enforcement of solid waste management laws in Kisii town. The data collected is presented in Table 2 below.

Kisii town has statistically significant enforcement of waste segregation regulations and laws 67.8% (Table 2). Although the literature on the county government's real rules regarding this activity is scant, the research findings indicate that informal youth groups have also taken on the job of on-site garbage segregation. This collaboration entails the implementation of solid waste segregation regulations and policies in Kisii County.

Table 2. Law enforcement in Kisii town.

	Policy	Agree %	Disagree %
1	Laws/policies on On-source solid waste segregation are enforced in Kisii town.	67.8 ± 1.2^{a}	32.2 ± 1.5^{b}
2	Waste generators are given incentives to enhance the on-source separation of solid wastes.	39.2 ± 3.2^{a}	60.8 ± 3.9^{b}
3	National government agencies have encouraged sustainable economically viable solid waste management mechanisms.	68.5 ± 1.4^{a}	31.5 ± 1.6^{b}
4	County departments of the Environment, Public Works and municipalities have enforced waste management laws in Kisii town.	63.6 ± 0.6^{a}	36.4 ± 0.7^{b}

Pearson Chi-Square value (61.475^{a}), $Asymp.Sig.(2-sided) = 0.047$, letters^{ab} in the same row differ statistically by Chi-square.

3.1.4. Waste as an Economic Resource in Kisii Town

The economic value attached to solid waste depends on the management and utilization of the items extracted from the waste. The efforts of Kisii County in adopting a circular economy are faced with numerous gaps as indicated in 4.

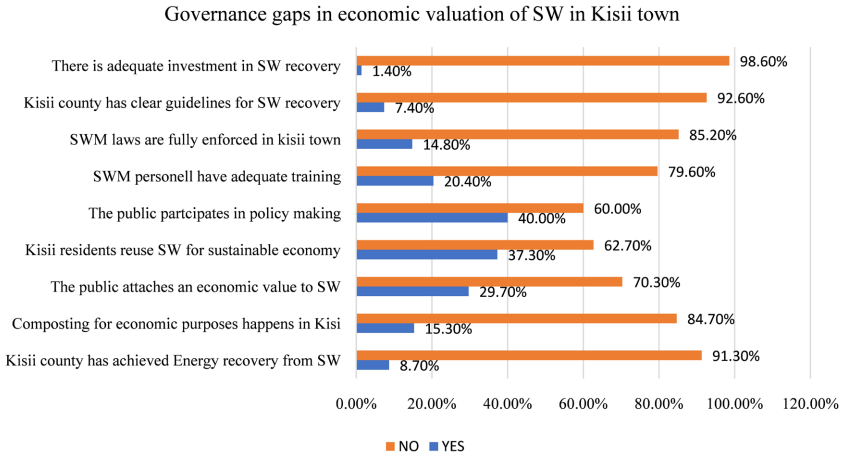


Figure 4. Governance gaps in economic valuation of solid wastes in Kisii town.

From the results obtained, Kisii County has not invested adequately in solid waste recovery (98.6%). As follows, the county lacks clear guidelines for SW recovery in Kisii town (92.6%). On the other hand, SWM laws are not enforced fully (85.2%) since the county personnel are not properly trained (79.6%). Nevertheless, the county at times may allow minimal public participation in policy formulation (40%). Even so, Kisii town residents are unable to reuse SW for a sustainable economy (62.7%) due to a negative perception of the economic value of SW (70.3%). On the other hand, Kisii County has not achieved much with composting (84.7%) as is the energy recovery from the SW (91.3%) (Figure 4).

3.1.5. Laxity of Residents in Waste Separation in Kisii Town

This study sought to determine whether there is laxity by the residents to separate their wastes at source points as pointed out in the CIDP 2017-2022 by the Kisii county government as shown in Figure 5.

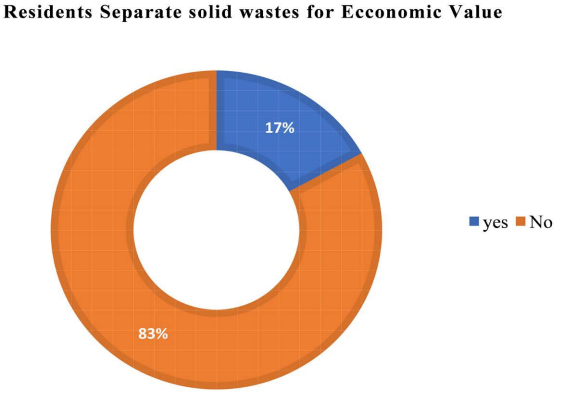


Figure 5. Laxity of residents in waste separation in Kisii Town.

The results indicate that the residents exhibit a major lapse of not separating their solid wastes at 83%. Only 17% of the respondents separate their waste. This is attributed to a lack of understanding/public awareness among the citizens of Kisii town on the need to separate solid wastes for the purposes of economic recovery. As a result of laxity in solid waste separation at the household level, there is environmental contamination, which hinders the move to a circular economy. As a result, in Kisii town, most residents fail to sort, reuse, and recycle, resulting in a rise in dumping in undesignated places (Ogutu et al., 2020). The 17% of the respondents who affirm ed they separate solid wastes are the few enlightened on re-use, composting, biogas production, and recycling of metallic products collected and sold to middlemen who transport to outside the county for recycling.

3.1.6. Duplicity of Players in SWM in Kisii Town

In examining the governance gaps in the economic valorization of solid wastes the study sought to determine whether there is more than one player in SWM performing the same role resulting in blame and how it hinders effectiveness and sustainability in Kisii town as shown in Figure 6 below.

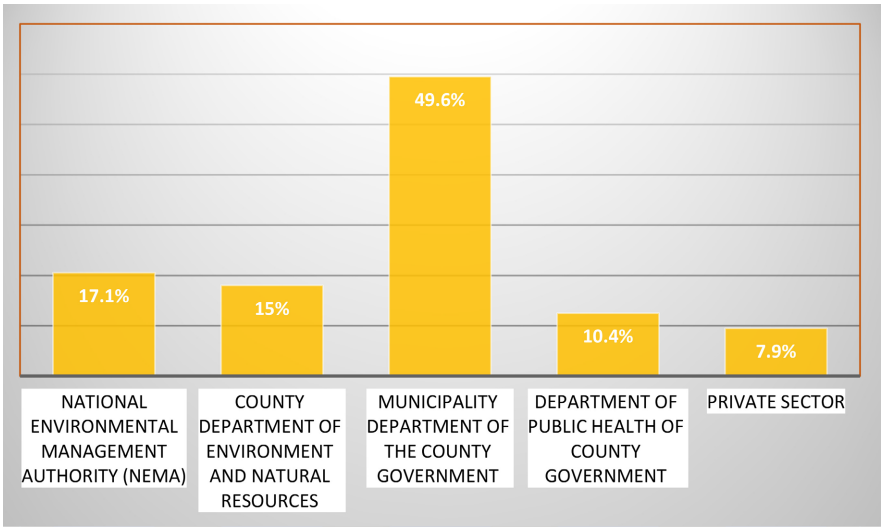


Figure 6. Different departmental entities are involved in SWM in Kisii town.

The findings indicate that solid waste is managed by multi-agencies in Kisii town. Many departments are involved including the county department of environment and natural resources 15% (as the overall overseer), the municipality department 49.6% (collection, transportation and disposal), public health department 10.4% (safety and occupational health), NEMA 17.1% (formulation of law, regulations and policies), private organizations 7.9% (collection and transportation) and informal youth groups (separation, collection and transportation). This hinder direct responsibility and who to be approached once there is an anomaly, especially by the residents.

3.1.7. Challenges Faced by the Kisii County in Solid Waste Management

One of the issues that the county government has is a lack of understanding among the citizens of Kisii town. Most individuals are unconcerned about the importance of a clean and healthy environment, which leads to inadequate solid waste management methods. As a result of poor waste management at the household level, there is environmental contamination, which hinders a move to a circular economy. As a result, in Kisii town, most residents fail to sort, reuse, and recycle, resulting in a rise in dumping in undesignated places (Ogutu et al., 2020). Furthermore, Kisii town residents' poor attitude toward solid waste management and failure to accept responsibility has significantly led to littering and open burning in undesignated areas.

4. Discussion

These findings show the incapacity of national government agencies and county authorities to implement legislated legislation through insufficient budgetary allocations, unclear SWM plans, poor coordination with national government agencies, a lack of efficient plan implementation, and an inability to value waste as a resource that the public can exploit for its utility. Furthermore, in Kisii County,

public participation is limited to a few solid waste management employees rather than the whole population. A small number of interviewees 10% stated that they were aware of Kisii County legislation that supports the economic value of garbage. However, many of the participants, who also happen to work in the solid waste management sector, were noticeably uninformed of any rules implemented by Kisii County to encourage the economic value of solid waste (**Figure 1**).

Previous research has found that Kenyan laws are largely in the national realm and are not well understood or implemented by the public (Oluoko & Mutisya, 2019). Kisii County, like the rest of Kenya, suffers from insufficient budgetary allocations, unclear SWM plans, poor coordination with national government agencies, a lack of efficient plan implementation, and an inability to value waste as a resource that the public can exploit for its utility (Mecheo et al., 2019). With these challenges, Kisii County inhabitants are unaware of any laws adopted by the county assembly to support the economic value of waste. In Kisii town, there are no or there are very few incentive schemes for waste generators to improve on-site trash segregation. According to **Table 2**, 60.8% of participants disapproved of the idea that waste generators are given incentives to promote on-site solid waste separation. However, only 39.2% of responders reported the presence of such incentives in Kisii town. Prior studies have revealed no intentions by the Kisii County administration to provide incentives to town residents to segregate waste before disposal (Mogaka et al., 2022).

According to Waste Management Laws 2006 Regulation 2, the generator is responsible for segregating, collecting, and disposing of waste in a manner that promotes a safe and hygienic environment for all. Furthermore, regulation 5 of the EMCA 1999 requires the generator to separate hazardous waste from other wastes before disposal under the regulations of the local authorities. Nonetheless, with an ever-increasing population and inadequate budgetary allocations to county governments, there is a lack of sufficient structures to completely execute the waste management laws of 2006 and the EMCA 1999. In addition, widespread corruption in numerous industries across countries impedes the efficient execution of rules that would create a circular economy. As a result, residents in metropolitan areas, including Kisii town, lack sufficient understanding of such restrictions and fail to separate their waste before dumping. Nonetheless, other non-formal entities involved in collecting will very certainly demand incentives to remove rubbish from estates before it is collected for disposal at the main dumpsite. Even if county administrations fall short of their mandate, the law does not require them to offer waste segregation incentives because this is the obligation of waste generators.

According to **Table 2**, 68.5% of respondents felt that national government agencies have been reassuring residents of measures that nurture and sustain a shift toward a circular economy. NEMA's National Solid Waste Management Strategy is based on the Zero Waste philosophy, with a focus on utilizing waste to produce income and jobs, to move toward a circular economy. In the strategy, NEMA es-

tablished and shared with county governments minimal waste management requirements to consistently promote compliance with management standards (NEMA, 2014). In this regard, the agency inspires county officials and the public to accept the solid waste management hierarchy, which specifies the preferred order of solid waste management solutions. The hierarchy in this strategy promotes waste reduction, reuse, recycling, resource recovery, incineration, and landfilling (NEMA, 2023). With the available information, Kisii inhabitants believe that government entities have encouraged sustainable economically feasible solid waste management techniques in the county.

Finally, it was determined that the County Departments of Environment, Public Works, and Municipality have enforced waste management rules in Kisii town (63.6%) (**Table 2**). A study by Mecheo et al. (2019) reveals, to some extent, adherence to the waste management hierarchy, despite being documented and officiated by county authorities. According to the report, trash disposal includes the usage of pits on estates, burning in some areas, and disposal at an authorized dumping site. Furthermore, county administrations, in collaboration with landlords, distribute bins that assist residents in segregating waste before disposal. To ensure that all solid waste is collected and transferred to official collection places, county departments and landlords work with nonformal youth groups that assist in waste separation for a fee while converting the waste into commercially viable items. County departments, on the other hand, have assured the availability of transport tractors and lorries to ensure that all garbage is collected and transported to the disposal site as soon as possible. Although not up to expectations, citizens may believe that the Kisii Departments of Environment, Public Works, and Municipality have implemented waste management rules in Kisii town.

In order to meet the challenges of municipal solid waste management, there is a need for technological advancements, community awareness, and implementation of good waste management practices. Increasing public awareness about degrading health and the environment is becoming a cause of concern for society. It is putting more and more pressure on Central and state-level governing bodies to find sustainable solutions to the problem of municipal solid waste management. There is a "need" to address the problem at the grassroots level to find lasting solutions. The current laws and regulations are unable to make an impact on obtaining a sound environment. Either the laws are not well understood or unable to implement successfully. Loopholes can be identified in the legal regime and there is a need for strictness in the application of the laws to see a change in the future. Providing municipal services and a clean environment is the primary responsibility of State municipalities and ULB's. Previous attempts made by the government at the central and state levels have been noteworthy but insufficient. Hence, there is an urgent need for better policies and legislative changes that promote waste minimization by collectively promoting responsibility towards the environment and matching with the changing conditions of lifestyle patterns of the Indian Society (Gupta & Goel, 2021).

According to Ighravwea and Edemb (2020), most developing countries can design rules that provide a clean and healthy environment, but they are never fully implemented. Furthermore, those in charge of executing policies to ensure the public's transition to a zero-waste and circular economy frequently conspire with perpetrators, jeopardizing the whole system. Kisii County government falls short of ensuring that enacted laws and policies are adequately enforced.

The major challenges of SWM are associated with the primary aspects of the waste sector (e.g., waste generation and inadequate waste collection, transport, treatment, and disposal processes). Villagers collect daily refuse in bamboo bins and compost the refuse in a pit (Mecheo et al., 2019). The villagers are trained from their childhood to help keep the village premises clean. A fine is also imposed on those who do not adhere to village regulations. Implementation of such steps should provide an example of how public awareness at the micro or village level can facilitate effective SWM. Managing waste logistics has several challenges. Inefficient waste logistic channels cause difficulties in managing the ingress and egress of solid waste from a waste dump to a treatment facility and vice versa. Speaking in the context of enterprises dealing with waste treatment, any malfunction in waste transport incurs severe losses. Operational efficiency has always been of the utmost importance in waste treatment facilities. The major challenge faced during waste treatment is Energy consumption. According to one estimate, about 23% of the energy consumed by a developing country is used to treat waste.

Countries with a high population density but a relatively small portion of arable land can also benefit via 3R, i.e., reduce, reuse, and recycle solid waste. In the US, incineration is very practical for jurisdictions with little availability of land, while landfilling, in contrast, dominates in jurisdictions that have a lot of available land (Subhasish et al., 2019). Environmental issues stemming from solid waste generation are often neglected during industrial and economic development (Li et al., 2015). Open dumping of solid waste, which is a common practice in poor and subsistence economies, affects many components of terrestrial ecosystems (Hossain et al., 2023). Open dumps are large stretches of land where solid wastes are dumped or piled without covering. Due to the simple operation and low-cost involvement, such open dumps are used extensively in underdeveloped and developing countries. There are numerous open dumps distributed across the world although their exact number is difficult to update. The International Solid Waste Association report estimated about 50 large open dumps in different continents with a total area of 2175 ha (ISWA, 2016).

According to Hossain et al. (2023), effective community involvement in solid waste management in the study area has not yet been achieved. This is due to a lack of commitment from the authorities to implement the plan, and the government and many people not adhering to existing standards and rules. The university administration has also shown a lack of attention to enforcing existing rules and standards. The lack of effective management and coordination has led to health and environmental hazards in the area. Recycling and separation of waste,

suitable solid waste treatment facilities, and implementation of an appropriate solid waste disposal system are essential. The government, NGOs, CBOs, and micro or small businesses should be given a chance to create energy from waste and increase community participation in waste management. Community-based education and awareness are essential to promote sustainable waste management practices. A green force of community members should be formed to act as a supervisory body and instill a sense of community spirit among members. The public should be educated on solid waste management rules and regulations, and penalties for non-compliance should be imposed. Participatory strategies for raising awareness, changing behaviors, and promoting social mobility and integrity should be implemented. Policies and guidelines for solid waste management should be developed and adopted by all stakeholders at the micro level to ensure uniform waste segregation, transportation, treatment, and disposal procedures.

Ntagisanimana et al. (2021) summarized the situation of solid waste management in EAC countries and analyzed their problems. It is found that income level determines the characteristics and management system of waste generated all over the world. The high cost of waste management tends to be a barrier in EAC countries and results in environmental pollution from unsanitary landfills, dumping, unsustainable composting and direct disposal of waste into inappropriate places. Unstainable waste management in EAC starts from waste generation to the final disposal due to poor sorting and collection. More than 62.5% of EAC solid waste is organic; these wastes can be sustainably composted and produce quality compost for EAC farmers. Sustainable composting and sanitary landfills will result in diverting dumped and inappropriately disposed waste to landfills and composting. Experience of developed and highly developing countries showed that WTE is more sustainable and increases with the economy. EAC countries should start pilot projects of WTE and make it a future priority with economic growth.

During the composting process, the evolution of temperature was strongly linked to the volume of the pile. Thus, the larger the volume, the higher the temperature during the thermophilic phase. Also, the evolution of the pH went through three different phases: an acidogenic phase, an alkalization phase, and finally, a neutrality phase towards the end of the process. The phytotoxicity test and the physico-chemical parameters measured showed that the composts obtained can be used as organic amendment and fertilizer since they are rich in organic matter and mineral elements (NPK). The use of compost was conditioned by the dose to be applied and by the type of crop.

Anokye et al. (2023) suggest that the success of waste management systems depends on several factors, including resources, infrastructure, and cultural practices. The substantial progress made by Karlsruhe's in WM is largely attributable to their conviction that an appropriate WM system is premised on sound key principles, powerful delivery service principles, and moving at a fiscally sensitive pace with as many locals as quickly as possible. Karlsruhe's waste management system is a model for sustainable waste management practices, and its success is

due to a culture of sustainability, adequate resources, and infrastructure.

Folarin (2022) asserts that an increase in the generation of solid waste remains inevitable as the population rises leading to an increase in the purchase of products, use and disposal. In addition, the environmental, health and social problems associated with solid waste disposal in developing countries will continue to be an economic burden without a sustainable waste management programme. Clearly, countries in Sub-Saharan Africa will continue to struggle with poor economic growth until significant steps are taken to drive circular enterprise. The integration of the circular business model into the economic programme of developing countries and its effective implementation will significantly reduce the burden of solid waste. Also, employment opportunities and means of livelihood are created through this waste management approach while sustainable development goals and targets are achieved.

Efforts to extend waste collection services to all citizens, eliminate open dumping and burning, and upgrade dumpsites depend as much on governance aspects as they do on technology and the infrastructure installed. Improving these basic and essential services will make a significant difference in the lives of billions of people around the world. It will also provide a solid foundation for further improvements to SWM, including the transition from a linear to a circular economy, and contribute to better governance in general (Rodic & Wilson, 2017).

Update the existing regulations and enhance enforcement of the regulations. Source separation and pre-treatment in the composting process should be improved. This measure could increase the quality of compost products and also have a positive effect on the performance of incinerators. Proper air pollution control equipment including dioxin control devices should be installed at the incinerator plant. Personal protection equipment such as hygiene masks and shoes must be purchased and distributed among the employees of the MSWM system. ν Recycling reduces expenses of collection and landfilling significantly. Therefore, expanding the source separation of recyclable waste is an essential issue. Promote the private sector involvement throughout the MSWM system. Increasing public awareness and providing the infrastructure to facilitate public participation.

5. Conclusion

The study settles that there exist governance gaps in the economic valuation of SWs in Kisii town. The residents' perception that waste has economic value is high but untapped for gain. The results indicate that most of the residents have limited knowledge of county laws geared towards the economic valuation of waste and evidence of limited public participation. Enforcement of laws, policies, and regulations is also a notable gap to foster sustainability in waste management. The results further point to inadequate trained personnel as a setback to sustainability. From the results, laxity in SWs separation and duplicity of roles and players is evident resulting in a lack of accountability and shifting of blame whenever a challenge occurs. This has mired the economic valorization of solid wastes to necessi-

tate environmental sustainability in Kisii town. For the circular economy to be realized in solid waste management these gaps in governance need to be addressed to apprehend economic value.

6. Recommendation

This study outlines the following recommendations:

(i) The Kisii County government needs to tap into the perception of the residents that waste has economic value to fast-track economic recovery which will foster a circular economy.

(ii) Public education through the media (radio, television, newspapers), banners, posters, public fora and other methods be carried out to educate the general public on the economic value of waste, this will inspire waste recovery ensuing environmental sustainability in Kisii town.

The Kisii County government should prioritize investing in solid waste recovery methods and have clear guidelines for SW recovery that are well known to the residents to enable the residents to cooperate in economic recovery thus promoting environmental sustainability and realization of the circular economy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Adebayo, B. I., & Bin Ismail, M. N. (2016). Solid Waste Management in Africa: A Review. *International Journal of Waste Resources, 6,* 1-14.

Andole, O. H. (2016). *The State of Solid Waste Management in Kenya*. Jomo Kenyatta University of Agriculture & Technology.

Anokye, K. Mohammed, A. S., Agyemang, P., Agya, A. B., Amuah, E. E. Y., Kwabi, L. A. et al. (2023). Improving Effective Solid Waste Management Systems in Ghana: A Comparative Study of the Cities of Karlsruhe, Germany and Navrongo, Ghana. *Open Access Library Journal, 10,* 1-12. https://doi.org/10.4236/oalib.1110854

Anomat, J., & Ibrahim, H. A. (2022). *Accelerating the Circular Economy in Plstic Waste Management for Kenya*. KIPPRA.

Aryampa, S., Maheshwari, B., Sabiiti, E., Bateganya, N. L., & Bukenya, B. (2019). Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability. *Sustainability, 11,* Article 5523. https://doi.org/10.3390/su11195523

Awasthi, M. K., Parameswaran, B., & Zhang, Z. (2019). The Special Issue on 'International Conference on Sustainable Solid Waste Treatments and Managements (SWTM-2019)'. *Bioengineered, 10,* 697-697. https://doi.org/10.1080/21655979.2019.1703630

Boulding, K. E. (2010). *The Circular Economy Waste Theory*. International Encyclopedia of Civil Society.

COK (2010). *The Constitution of Kenya.*

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publications.

Folarin, O. S. (2022). Achieving Sustainable Solid Waste Management in Sub-Saharan Af-

rica: The Option of Valorisation and Circular Economy Model. In A. Z. Yaser, H. A. Tajarudin, & A. Embrandiri (Eds.), *Waste Management, Processing and Valorisation* (pp. 285-300). Springer. https://doi.org/10.1007/978-981-16-7653-6_15

GOK (2021). *The Government of Kenya.* Government Press.

Gupta, V., & Goel, S. (2021). Good Governance and Solid Waste Management: An Overview of Legislative Regulations in India. *Journal of Business & Management Studies, 2,* 1-9.

Hannon, J., & Zaman, A. U. (2018). Exploring the Phenomenon of Zero Waste and Future Cities. *Urban Science, 2,* Article 90. https://doi.org/10.3390/urbansci2030090

Haregu, T. N., Ziraba, A. K., Aboderin, I., Amugsi, D., Muindi, K., & Mberu, B. (2017). An Assessment of the Evolution of Kenya's Solid Waste Management Policies and Their Implementation in Nairobi and Mombasa: Analysis of Policies and Practices. *Environment and Urbanization, 29,* 515-532. https://doi.org/10.1177/0956247817700294

Hossain, M. J., Mahmud, M. M., & Moinuddin, G. (2023). Integrated Solid Waste Management for Closed Community: An Experiment on Jahangirnagar University Campus. *Waste Technology, 11,* 75-90.

Ighravwea, D. E., & Edemb, I. E. (2020). Municipal Waste Management Sustainability in Developing Countries: An Analysis of Research Directions. *The Journal of Solid Waste Technology and Management, 46,* 328-341. https://doi.org/10.5276/jswtm/2020.328

ISWA (2016). *The International Solid Waste Association Report.*

Kamble, A. C. (2022). Solid Waste Management for Circular Economy towards Sustainable Development of India. *International Journal of Food and Nutritional Sciences, 11,* 3878-3884. https://www.researchgate.net/publication/378660012

Kamil, F. H., & Abood, W. M. (2021). *Circular Economy and Solid Waste Management for Sustainable Environments.* https://www.researchgate.net/publication/357555187

Kanda, E. K., & Cherono, K. (2020). Evaluation of Solid Waste Management Practices in Kakamega Municipality, Kakamega County. In A. Nurmandi, H. Latief, A. Gomes, Z. Rafique, B. Wadham, B. Barendregt et al. (Eds.), *Proceedings of the 4th International Conference on Sustainable Innovation 2020* (pp. 94-99). Atlantis Press.

KNBS (2019). *Kenya National Bureau of Statistics.*

Li, H., Nitivattananon, V., & Li, P. (2015). Developing a Sustainability Assessment Model to Analyze China's Municipal Solid Waste Management Enhancement Strategy. *Sustainability, 7,* 1116-1141. https://doi.org/10.3390/su7021116

Manteaw, B. O., & Boachie, J. (2019). Africa's Urban Waste Management and Sanitation Challenges: Are Transfer Stations the Solution? *Environment and Pollution, 9,* 1-13. https://doi.org/10.5539/ep.v9n1p1

Mecheo, N. O., Omondi, P., & Nunow, A. (2019). Nature and Collection Systems of Domestic Solid Wastes in Kisii Town, Kenya. *World Environment, 9,* 1-12.

Mogaka, E. (2022). *Project Planning on Implementation of Solid Waste Management Practices in Kisii Central Sub County, Kisii County Kenya.* Doctoral Dissertation, University of Nairobi.

NEMA (2014). *The National Solid Waste Management Strategy.* https://www.nema.go.ke/images/Docs/Media%20centre/Publication/National%20Solid%20Waste%20Management%20Strategy%20.pdf

NEMA (2023). *Waste Management Regulations.* https://www.nema.go.ke/images/Docs/Regulations/Waste%20Management%20Regulations-1.pdf

Nolasco, E., Duraes, P. H. V., Gonclaves, J. P., de Oliveira, M. C., de Abreu, L. M., & de

Almeida, A. N. (2020). Characterization of Solid Wastes as a Tool to Implement Waste Management Strategies in a University Campus. *International Journal of Sustainability in Higher Education, 22,* 217-236. https://doi.org/10.1108/ijshe-12-2019-0358

Ntagisanimana, G., Yu Z., & Ma, H. (2021). Current Situation of Solid Waste Management in East Africa Countries and the Proposal for Sustainable Management. *African Journal of Environmental Science and Technology, 15,* 1-15. https://doi.org/10.5897/AJEST2020.2911

Ochieng, G. (2016). *Challenges and Possible Interventions for Effective Solid Waste Management in Ngomongo Village of Korogocho Informal Settlement, Nairobi County*. Master's Thesis, University of Nairobi.

Ogutu, F. A., Kimata, D. M., & Kweyu, R. A. (2019). The Role of Environmental Governance in Solid Waste Management, Policy Implementation in Nairobi County. *Civil and Environmental Research, 11,* 49-54.

Ogutu, F. A., Kimata, D. M., & Kweyu, R. A. (2020). A Critique on Sustainable Cities Waste Management Predicaments; Case of Nairobi City, Kenya. *Journal of Applied Sciences and Environmental Management, 24,* 1801-1810. https://doi.org/10.4314/jasem.v24i10.14

Oluoko, A. A., & Mutisya, E. (2019). The Enterprise of Waste Management among Urban Youth for Sustainable Development in Kenya. *Journal of Sustainability, Environment and Peace, 1,* 45-51.

Orhorhoro, E. K., & Oghoghorie, O. (2019). Review on Solid Waste Generation and Management in Sub-Saharan Africa: A Case Study of Nigeria. *Journal of Applied Sciences and Environmental Management, 23,* 1729-1737. https://doi.org/10.4314/jasem.v23i9.19

Rodić, L., & Wilson, D. (2017). Resolving Governance Issues to Achieve Priority Sustainable Development Goals Related to Solid Waste Management in Developing Countries. *Sustainability, 9,* Article 404. https://doi.org/10.3390/su9030404

Rodic, L., Scheinberg, A., & Wilson, D. C. (2010). Comparing Solid Waste Management in the World's Cities. In Key-Note Paper at ISWA World Congress 2010, Urban Development and Sustainability—A Major Challenge for Waste Management in the 21st Century (pp. 1-16).

Ryota, O. (2024). *Initiatives to Achieve Clean Cities in Kenya, Technology from Promoting Circular Economy*. Japan International Cooperation Agency.

Sadeghi Ahangar, S., Sadati, A., & Rabbani, M. (2021). Sustainable Design of a Municipal Solid Waste Management System in an Integrated Closed-Loop Supply Chain Network Using a Fuzzy Approach: A Case Study. *Journal of Industrial and Production Engineering, 38,* 323-340. https://doi.org/10.1080/21681015.2021.1891146

Subhasish, D., Lee, S. H., Pawan, K., Kim, K. H., Lee, S. S., & Bhattachavya, S. S. (2019). Solid Waste Management: Scope and the Challenge of Sustainibility. *Journal of Cleaner Production, 228,* 658-678.

The Kisii County Solid Waste Management Act (2015).

Un-Habitat (2010). *Solid Waste Management in the World's Cities*. Routledge. https://doi.org/10.4324/9781849774871

Upadhyaya, L. (2013). *The Zero Waste Theory*. Centria University.