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Existing household solid waste source separation practices and their contribution towards sustainable solid waste management: The case of Kisumu City, Kenya

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Abstract

Sustainable solid waste management is a global concern. An effective measure to improve the waste management levels and convert household solid waste into useful materials is to conduct source separation instead of just collecting and burning or burying it. This study adopted a descriptive survey design to determine the current household solid waste source separation practices and how they contribute towards sustainable solid waste management in Kisumu City of Kisumu County, Kenya. Primary data was collected through questionnaires, structured interviews and checklists, while secondary data was acquired through a document review of relevant literature. The data was descriptively analysed on SPSS program. The study found that 80 percent of the respondents believed that household waste separation was possible (mean = 1.26; standard deviation = 0.439). About 62 percent of respondents practiced waste separation before disposal, particularly for food waste, recyclables, and plastics (mean = 2.72; standard deviation = 1.387). About 96 in every 100 respondents believed that separation of household solid waste could enhance hygiene at home (mean = 1.04; standard deviation = 0.202). A significant note was that about 70 percent of the respondents indicated attempting to sensitize their household members on the importance of separation of household solid wastes (mean = 1.30; standard deviation = 0.458). The study recommends the development and implementation of comprehensive public awareness and education initiatives to promote residents' household solid waste source separation behaviour. Such a practice would positively impact on the environment and bring along with it economic advantages of income generation through sale of recyclable materials.

Keywords: Household solid waste; Source separation; Recyclable material; Non-recyclable material; Solid waste management; Kisumu City

1. Introduction

Household solid wastes are the non-liquid and non-gaseous materials that emanate from households and are no longer required (Olatubosun et al., 2023). They contribute a large portion of the Municipal Solid Waste (MSW) in many cities of the world (European Commission, 2008). The management of household solid waste (HSW) represents one of the greatest challenges currently faced by waste managers all around the world (Ojijo, 2023). This is more so due to the increasing economic growth, purchasing power and population size that yields higher waste generation in most cities of the world (Innocent *et al.*, 2015). In 2012, the global municipal solid waste generation levels were approximately 1.3 billion tons per year and were expected to increase to approximately 2.2 billion tons per year by 2025 (World Bank,

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2012). The vast amount of solid waste envisaged requires management systems that aim at reducing or preventing the amount of waste.

Many developing countries display a common characteristic, that is, an imbalance between rapid population and sanitary infrastructural provision. The situation is worsened by the challenges of poor waste management practices affecting the already deteriorating ecosystem of the fast-growing cities of these countries (Elias *et al*., 2012). Kisumu is one of the flourishing and dynamic regions of Kenya, particularly when it comes to economic growth (Ojijo, 2023). NEMA (2015) observed that the city produced about 400 tonnes of solid waste per day, but only about 20 per cent was collected. Munala & Moirongo (2011) maintained that the quantities of solid waste generation in Kisumu were likely to increase due to improved income levels, increasing population, changing lifestyles and consumption patterns.

Sustainable waste management has remained elusive in the city due lack of adequate funding and skilled personnel besides poor waste attitude towards waste management (Awuor et al., 2020). Significant progress to improve household solid waste management was hindered by the difficulties the city authority faced while trying to relocate the overflowing dumpsite at Kachok (Sibanda *et al*, 2017). Poor Solid Waste Management (SWM) practices contribute to the loss of resources, global warming and adverse impacts on public health systems (Mulatya, 2011). Effective and sustainable SWM evolves through waste awareness among the general public, social inclusivity and political willingness. Sustainable waste management is in line with the proposed targets of Urban Sustainable Development Goals SDGs. The 11th goal targets to reduce adverse per capita environmental impact of cities, including paying special attention to air quality, municipal and other waste management by 2030 (Simon *et al.,* 2015).

An effective measure to improve waste management levels and convert HSW into useful materials is to conduct source separation instead of just burning or burying it (Chen, 2017). This paper sought to examine the existing household solid waste separation practices and their contribution towards sustainable solid waste management in Kisumu City of Kenya. Source separation and recycling are important elements in SWM as both offer sustainable and effective solutions to mounting waste (Nadia *et al.,* 2018). The main body of source separation is the community resident (Zhang & Wen, 2014). The practice applies the 3R principles (reduce, reuse, and recycle) to enhance waste recycling and reduce disposal amount (Chung & Poon, 2001). Rahman et al., (2017) agreed that waste separation at source was very important in the 3R initiative. Separating waste at the source directly supports material recovery by producing a more homogenous and high-value stream which is easier to recover.

2. Literature review

There is an indication that how solid waste is managed is as diverse as the human race itself (Zhou et al., 2022). Source separation of waste is a practice of the 3R principle since it encourages recycling and reduces disposal amount (Chung & Poon, 2001). Separation at source involves setting aside post-consumer materials and household goods so that they do not enter mixed waste streams (Lardinois & Furedy, 1999). The purposes are for recycling, reuse or improved waste management. Effective source separation is a precondition for comprehensive utilization of recyclable waste and organic waste. Source separation promotes the removal of all designated recyclable materials from the waste stream, helps in achieving high reduction rates, and creates saleable materials by reducing the extent of contamination (Rahman et al., 2017). Khan *et al*. (2018) agreed that solid waste separation is a preferable way of SWM which could decrease the issue of landfilling, and consequently extend the lifespan of existing landfills. In this study, the term separation was used interchangeably with segregation and sorting.

Different countries have different systems of separation; some use traditional systems while others have collective systems. Developed countries have organized systems of separation usually meant for recycling and composting (Lardinois & Furedy, 1999). In Malaysia, waste separation is mandatory for all households, and the scheme seeks to prevent indiscriminate disposal of recyclable materials, reduce the amount of waste sent to landfill, and reduce financial allocation (Khan *et al.,* 2018). Recyclable waste materials generated in Malaysia include paper, plastic and bottles, out of these, very little of the waste is recycled by households. In Kuala Lumpur, for instance, the recycling rate is 5% (Innocent, 2015).

A study carried out in Suzhou City, China, reported that 23% of respondents had source-separated HSW into three kinds of waste, that is, stored recyclables at home then sold to waste buyers or threw them into community-separated garbage bins, separated food waste at home and threw them into community separate garbage bins, and stored hazardous waste and threw into community separated garbage bins. About 21% have not source-separated HSW at all; and the remaining 56% had partially separated one or two kinds of wastes from HSW (Zhang & Wen, 2014). In Sweden, households commonly use bins of varying sizes to separate waste (Seadi *et al.,* 2013). In other European countries, in addition to the bin system, a survival bag approach was used by households for the separate collection of digestible waste streams:

dry recycling, residual waste, and digestible waste. In a project carried out in Umea Municipality, Sweden, VALORGAS European Project, VALORGAS (2012) reported that 68% of the detached houses source-separated their food waste either in separate bin (56%) or by home composting (12%).

In contrast, a study carried out in Dhaka city, India, reported that the recyclables with economic value such as waste paper, plastic, broken glass and metals were not segregated and were thrown on the streets by households along with domestic waste (Rahman et al.,2017). A survey in Bulawayo, Zimbabwe, reported that only a few respondents (28.6%) separated organic waste from inorganic waste whereas 71.4% of them threw all their waste in waste bags (Sinthumule & Mkumbuzi, 2019). It further reported that 67.2% of the respondents threw litter in the bin while outdoors, while (32.8%) threw waste anywhere because the bags were few and dilapidated.

The number of categories into which wastes generators separate their wastes differs from country to country. A study carried out by Okot-Okumu (2012) revealed that waste in East African urban centres is generally comprised of decomposable organic materials (65-70%), paper (5-9%), plastic (6-12%), glass (0.47-4%), metal (0.3-3%), and other waste (0.4-1%). This composition can allow for variation of categories into which solid wastes can be separated. The organic wastes from households can be used as animal feeds, to prepare fertilizers or produce biogas while paper, plastics and metals can be recycled or sold to recyclers hence reducing the amount of solid wastes reaching the landfills.

NEMA (2015) maintained that there was lack of waste segregation at source in Kenyan urban centres leading to mixed wastes which are collectively disposed-off at dumpsites. A study carried out by Machio (2017) indicated that most households in the informal settlements in Nairobi simply discarded or burned their solid waste. In Kisumu City, a labelled and colour-coded three- bin system is in place in the CBD to facilitate the separation of waste at the source but the culture of waste separation is not engrained in the public (Aura, 2013; Awuor, 2016). A study by Damghini et al. (2008) noted that colour-coded containers for storing different types of solid waste offered more cost-effective waste management services improving household waste separation and reducing the amount of waste in landfills.

Guided by the Behavioural Change Theory (BCT) and the Participation Theory (PT), this study conceptualised that household solid waste separation practices influence sustainable solid waste management either directly or through the proxy of environmental regulatory policies. The framework broke down the independent variable into three, that is: (1) factors influencing residents' HSW source separation behaviour, (2) reasons for non-separation of HSW, and (3) percentage of respondents who believe in HSW source separation. The dependent variable encompassed the frequency of HSW collection, payment for HSW collection, support from waste management service providers, recycling and material recovery, and the influence of other stakeholders. These indicators collectively represent the various facets of sustainable waste management in the context of Kisumu city of Kenya.

3. Research methodology

3.1. Study area

Kisumu City is situated on the shores of Lake Victoria and is the third largest city in Kenya after Nairobi and Mombasa. It covers a total area of 417km^2 and of this, 297 km^2 is dry land and the remaining 120 km^2 is underwater (Onyango *et al.,*2013). The city lies between latitude 00°02'N; 00°11'S and longitude 34^{0}35'E and 34^{0}55'E at an elevation of 1,131 meters above sea level.

The city has a sub-humid and semi-humid tropical climate which is modified by the presence of Lake Victoria which is the largest freshwater lake in Africa. Kisumu has an annual relief rainfall that ranges between 1200 mm and 1300 mm in different seasons. The rainfall has two marked peaks between March and May when heavy rain is expected while short rain falls between November and December ((NEMA, 2007). Temperature ranges between 20 ^{0}C and 35 ^{0}C but sometimes falls below 19^{0}C. Humidity is relatively high throughout the year (NEMA, 2007).

Kisumu City serves both as the County headquarters and the principal town in the region. Kisumu City is an inland port in western Kenya. The city has a large population of 174,145 (KNBS, 2019). Kisumu central has two locations, that is, Town and Kondele, and six administrative wards namely Railways, Migosi, Shaurimoyo-Kaloleni, Market- Milimani, Kondele and Nyalenda 'B'. There are nine sub-locations namely Kanyakwar, Bandani, Nyawita, Migosi, Kaloleni, Northern, Southern, Manyatta 'A' and Nyalenda'B'.

3.2. Research design

The study adopted a descriptive survey design. The design was appropriate for the study since it enabled the researcher to collect information about the opinion and attitudes of respondents. The study applied both quantitative and qualitative approaches. The quantitative approach employed a close-ended section of the questionnaires to collect data while the qualitative approach embraced interviews and an open-ended section of the questionnaire. The combination of the two approaches allowed the researcher to collect diverse forms of data.

3.3. Data analysis

The collected data was entered into a data-based designed Ms-Excel 2016 and exported into SPSS, then analysed using appropriate statistical tools. Quantitative data collected was coded, grouped into various thematic areas and analyzed using descriptive statistics. The descriptive statistics involved frequencies, percentage, mean and standard deviation. Qualitative data were transcribed, organized into various themes of the study and reported in a narrative form.

4. Results and discussion

4.1. Demographic characteristics of the respondents

4.1.1. Distribution of respondents by gender

The study sought to establish the distribution of the respondents by gender. The results are shown in Table 4.4.

Table 1 Distribution of respondents by gender

Gender		Frequency	Percent
	Male	142	44.4
	Female	178	55.6
	Total	320	100.0

Source: Researcher (2023)

Table 1 presents the findings of the study regarding gender distribution among the respondents. Based on the data, out of the total 320 respondents, 44.4% (142) were male, while 55.6% (178) were female. These findings indicate that the study included a balanced representation of both male and female respondents. The gender distribution provides a comprehensive perspective on the views, behaviours, and practices related to household solid waste (HSW) source separation in Kisumu City of Kenya. Analysing the data about the study objectives helped identify any potential gender-specific differences, preferences, or influences in residents' HSW source separation activities, factors affecting participation, and the overall contribution of different genders towards sustainable solid waste management.

4.1.2. Distribution of respondents by age

The study sought to establish the distribution of the respondents by age. The results are shown in Table 4.5.

Table 2 Distribution of the respondents by age

Age		Frequency	Percent
	18-28	176	55.0
	29-39	87	27.2
	40-50	56	17.5
	Above 51	1	0.3
	Total	320	100.0

Source: Researcher (2023)

Table 2 presents the findings of the study regarding the age distribution among the respondents. The table provides information on the frequency, percentage, valid percentage, and cumulative percentage for each age category. Out of

the total 320 respondents, the majority fall within the age range of 18-28, constituting 55.0% (176) of the participants. The next largest age group is 29-39, accounting for 27.2% (87) of the respondents. The age group of 40-50 represents 17.5% (56) of the participants. There is only one respondent (0.3%) who is above 51 years of age. These findings indicate that the study included a diverse range of age groups, with the majority of respondents being relatively young (18-28 years old). This age distribution provides insights into the perspectives, behaviours, and practices related to household solid waste (HSW) source separation across different age groups in Kisumu City of Kenya. Analysing the data about the study objectives helped identify any potential age-related differences, influences, or preferences in residents' HSW source separation activities, factors affecting participation, and the overall contribution of different age groups towards sustainable solid waste management.

4.1.3. Distribution of respondents by level of education

The study sought to establish the distribution of the respondents by level of education. The results are shown in Table 3.

Table 3 Distribution of respondents by level of education

Level of education		Frequency	Percent
	Secondary	28	8.8
	Collage	96	30.0
	College Diploma	96	30.0
	University	100	31.2
	Total	320	100.0

Source: Researcher (2023)

The results in Table 3 shows that 8.8% (28) of the respondents had a secondary level of education. About 30.0% (96) of the respondents attended college. Another 30.0% (96) held a college diploma. Another 31.2% (100) of the participants had a university education. These findings indicate that the study included participants from a diverse range of educational backgrounds. Analysing the data about the study objectives helped identify any potential relationships between the level of education and residents' HSW source separation activities, factors influencing participation, and the contribution of different education levels towards sustainable solid waste management in Kisumu City of Kenya. The distribution of respondents by education level allowed for a comprehensive understanding of how educational attainment impacted residents' knowledge, attitudes and behaviours related to household solid waste source separation. A study done in Portugal by Debrah et al. (2021) emphasised the importance of education in shaping environmental attitudes geared towards sustainable waste management practices.

4.1.4. Distribution of respondents by number of members in the household

The study sought to establish the distribution of the respondents by number of members in the household. The results are shown in Table 4.

Table 4 Distribution of respondents by number of members in the household

No. of household members		Frequency	Percent
	1-5	194	60.6
	6-10	120	37.5
	Above 10	6	1.9
	Total	320	100.0

Source: Researcher (2023)

From Table 4, out of the total 320 respondents, 60.6% (194) of them reported having 1-5 members in their households. 37.5% (120) of the respondents indicated that their households have 6-10 members. Only 1.9% (6) of the participants reported having more than 10 members in their households. The study findings suggest that a significant majority of the respondents had relatively smaller households, with 1-5 members being the most common category. On the other

hand, households with 6-10 members constituted the second most common category. Households with more than 10 members were relatively rare in the sample. Interpreting these findings in the context of the study objectives provided insights into how household size influenced residents' HSW source separation behaviours and practices. Smaller households may have different waste generation patterns and source separation habits compared to larger households. Additionally, understanding the household size distribution can help waste management authorities and stakeholders design targeted waste management strategies tailored to different household types and sizes, ultimately contributing to sustainable solid waste management efforts.

4.2. Household solid waste source separation practices and sustainable solid waste management

Descriptive statistics was done to determine the HSW source separation practices and how they contributed towards sustainable solid waste management. The findings are shown in Table 5.

Table 5 Solid waste source separation practices and sustainable solid waste management

	N	Mean	Std. Deviation
Do you think household waste separation is possible? (1=Yes; 2=No)	320	1.26	0.439
Do you separate your household solid wastes before disposal? (1=Yes; 2=No)	320	1.38	0.487
Which wastes do you mainly separate before disposal? (1=Food wastes; 2=Recyclables; 3=Metals; 4=Hazardous waste; 5=Plastics; 6=Other)	320	2.72	1.387
If you do not separate household solid wastes, give your main reason (1=Inadequate waste storage containers; 2=It is time-consuming; 3=It is inconvenient; 4=It is dirty work; 5=I do not have sorting skills; 6=other).	320	2.60	1.611
In your opinion, do you think that the separation of household solid waste can enhance hygiene at home? 1=Yes; 2=No)	320	1.04	0.202
Indicate what you think about the separation of household solid wastes (1=Very important; 2=Important; 3=Not important)	320	1.20	0.399
Have you made any attempt to sensitize your household members on the importance of separation of household solid wastes? (1=Yes; 2=No)	320	1.30	0.458
Valid N (list-wise)	320		

Source: Researcher (2023)

A majority of respondents (approximately 80%) believed that household waste separation was possible (Mean = 1.26). This finding indicated a positive attitude towards waste separation practices among the residents of Kisumu City of Kenya. This optimistic outlook suggests that there is potential for further promoting and expanding HSW source separation initiatives to achieve sustainable waste management.

Around 62% of respondents stated that they separate their household solid wastes before disposal (Mean = 1.38). This is in agreement with a study done in India by Eshwari et al (2019) that found about 71% of the residents to have separate bins for dry and wet waste. Elsewhere, the South Korean government enforces source separation regulations for food waste. This finding demonstrates a significant proportion of residents engaging in waste separation practices. However, there is still room for improvement, as a considerable number of respondents (about 38%) do not practice waste separation. Addressing the barriers to participation for this group will be crucial in enhancing sustainable waste management efforts.

The survey revealed that respondents mainly separated food wastes, recyclables, and plastics before disposal (Mean = 2.72). This finding indicated that residents were more likely to focus on segregating organic waste and recyclable materials, which aligns with sustainable waste management goals. However, there is room to promote the separation of hazardous waste and metals, which are currently separated by a smaller proportion of respondents. On the African continent, studies have revealed lack of solid waste separation at the source while others have indicated that only few

residents separate organic waste (Oberlin 2011; Rigasa et al., 2017; Rahman et al., 2017; Sinthumule & Mkumbuzi, 2019).

Among those who did not separate their household solid wastes, the main reasons cited were inadequate waste storage containers, the perception of time consumption, inconvenience, and the perceived unpleasantness of the task (Mean = 2.60). Verbatim responses from respondent Y stated that, *"The level of awareness is high, but only few people are implementing due to lack of time".* Understanding these barriers is crucial for devising targeted interventions to overcome them. Addressing these concerns through improved waste management infrastructure, educational campaigns, and incentives may encourage more residents to adopt waste separation practices. A study done by Hettiarachi (2018) in the Caribbean and Latin America underscored the essence of awareness campaigns by reporting that raising consciousness through campaigns positively influenced the attitudes and behaviours of various stakeholders involved in solid waste management.

The findings suggest that a significant majority of respondents (approximately 96%) believed that the separation of household solid waste could enhance hygiene at home (Mean = 1.04). Additionally, the majority of respondents (around 80%) considered waste separation as either "Very important" or "Important" (Mean = 1.20). These results indicate a strong positive perception of the hygiene benefits and importance of waste separation. Leveraging these positive attitudes can reinforce the message of waste separation's significance in achieving sustainable and hygienic living conditions.

Approximately 70% of respondents reported making attempts to sensitize their household members on the importance of separation of household solid wastes (Mean = 1.30). This finding suggests that some residents are taking the initiative and actively promoting waste separation practices within their households. Encouraging and supporting such sensitization efforts could further amplify the impact of waste management programs and foster a culture of waste separation at the community level.

Generally, the findings indicate that there was a positive inclination towards household solid waste (HSW) source separation practices in Kisumu City of Kenya. Many residents already practice waste separation, particularly for food wastes and recyclables. The leading intentions of such solid waste separation being to keep their environments clean and to recycle the recyclables. This finding is in line with findings of other global studies (Guo et al., 2022; Liu et al., 2023). For instance, a China-based study by Liu et al. (2023) found positive attitude among Chinese residents to significantly influence household solid waste sorting behaviour. However, there are still challenges to address, such as the barriers faced by those who do not separate waste, the need to promote the separation of other waste types like hazardous materials, and improving waste management infrastructure. Overall, the results underscore the importance of continued efforts to promote and expand HSW source separation practices for more sustainable solid waste management in the city. Building on the positive attitudes and perceptions of residents, the implementation of targeted interventions, stakeholder collaboration, and public awareness campaigns can lead to a significant positive impact on waste management practices and the environment. This is further displayed in Plate 1.

Figure 1 Solid waste disposed within Manyatta slums

This study was based on the assumption that the respondents would be cooperative and thus, willingly divulge information required for the questionnaire and interview schedules; provide truthful and honest responses to the items

in the questionnaire; and be knowledgeable enough to understand the questions and to answer them well. Since this cannot be perfect, the study might have suffered minimal errors. However, the engagement of a wide and varied study population made the study valid.

5. Conclusion

This study sought to examine the influence of current household solid waste (HSW) source separation practices on sustainable solid waste management in Kisumu City of Kenya. Majority of respondents believed that household waste separation was possible and around 62% reported practicing waste separation. Food wastes, recyclables, and plastics were the most commonly separated waste types, while hazardous waste and metals were less frequently separated. Barriers to waste separation included inadequate waste storage containers, time consumption, inconvenience, and perceived unpleasantness. However, respondents recognized the hygiene benefits and importance of waste separation. A significant proportion of respondents also reported making efforts to sensitize their household members on waste separation.

The study recommends development and implementation of comprehensive public awareness and education initiatives to promote residents' household solid waste (HSW) source separation behaviour. These initiatives should be designed to raise awareness about the environmental, health, and economic benefits of HSW source separation. Emphasis should be placed on the positive impact of HSW separation on the environment, such as reducing landfill waste, conserving resources through recycling and minimizing pollution is critical. Highlighting the health benefits of proper waste separation is highly recommended, including improved hygiene and sanitation practices. Furthermore, underscoring the economic advantages, such as potential income generation through the sale of recyclable materials is highly endorsed.

Compliance with ethical standards

Disclosure of conflict of interest

The authors of this publication declares that there are no competing conflict of interest in the work. The authors further declare that they did not receive any support from any organization for the submitted work.

Statement of informed consent

Informed consent was obtained from all participants who were included in the study.

References

[1]   Aura, C. M. (2013). Assessment of extent to which Plastic Bag Waste Management Methods Used in Nairobi City Promote Sustainability. *American Journal of Environmental Protection, 1*(4), 96-101.

[2]   Awuor, F. O. (2016). Provider value perception in co-creation, ecotourism offering development and classification at Dunga Beach in Kisumu, Kenya. *Unpublished PhD Thesis: Jaramogi Oginga Odinga University of Science and Technology, Bondo, Kenya*.

[3]   Chen, H., Yan, Y., Wei, J., Mengjie, S., Ying, W. & Tiantian, X. (2017). Source Separation of Municipal Solid Waste: The Effects of Different Separation Methods and Citizens' Inclination - Case Study of Changsha, China. *Journal of Air & Waste Management Association, 67* (2), 182-195. Doi:10:1080/10962247.2016.1222317.

[4]   Chung, S. S. & Poon, C. S. (2001). A Comparison of Waste-Reduction Practices and New Environmental Paradigm of Rural and Urban Chinese Citizens. *J. Environ. Manage*. 62(1):3-19. Doi:10.1006/jema.2000.0408.

[5]   Damghani, A. M., Savarypour, G., Zard, E., & Deihimfard, R. (2008). Municipal Solid Waste Management in Tehran: Current Practices, Opportunities and Challenges. *Waste Manag*. 2008, 28/929-934.

[6]   Elias, M., Gumbo, T., & Gondo, T. (2012). Waste Management Threats to Human Health and Urban Aquatic Habitats - A Case Study of Addis Ababa, Ethiopia.

[7] European Commission. (2008). Directive 2008/98 IEC. Retrieved from http://euro-lex.europa.eu/legal-content/EN/TXT/HTML/uri=celex:32 008L00980rid=1

[8] Innocent, A. J, Chamhuri, S., Rawshan, A. B., Basri, A. T. &Mahmudul, A. (2015). Assessing Problems and Prospects of Solid Waste Management in Malaysia. Vol.10, No 2(2015) 070-078, ISSN:1823-884x.

[9] Khan, I. N., Adibah, S.W. & Nopiah, Z.M. (2018). Solid Waste Separation at Source among Households for Sustainable Waste Management. The Application of the Solid Waste and Public Cleansing Management Act 2007. *International Journal of Asian Social Science*. Doi:10.18488/journal.I.2018.84.201.207.

[10] KNBS. (2019). Kenya Population and Housing Census Report 2019. *Kenya National Bureau of Statistics*.

[11] Lardinois, I. & Furedy, C. (1999). Source Separation of Household Waste Materials: Analysis of Case Studies from Pakistan, the Philippines, India, Brazil Argentina and the Netherlands. *Gouda, The Netherlands*. ISBN 9076639019.

[12] Machio, C. M. (2014). Participation of Households in Solid Waste Management in Kayole Soweto Informal Settlements, Nairobi City, Kenya. *Unpublished Master's Thesis, University of Nairobi*.

[13] Mulatya, D. M. (2011). Nairobi Household Solid Waste Management Practices; Need for Re-strategizing. *Masters' Thesis Presented at Jomo Kenyatta University of Agriculture and Technology*.

[14] Munala, G., & Moirongo, B. O. (2011). The Need for Integrated Solid Waste Management in Kisumu, Kenya. *Journal of Agriculture Science and Technology*,13(1), 65-78.

[15] Nadia,I., Adibah, W.S. & Nopiah, Z.M. (2018). Solid Waste Separation at Source among Households for Sustainable Solid Waste Management: The Application of the Solid Waste and Public Cleansing Management Act 2007. *International Journal of Asian Social Science*. Doi:10.18488/Journal.I.2018.84.201.207 vol 8, No 4,201-207.

[16] NEMA (2007). The National Solid Waste Management Strategy. Retrieved from www.nema.go.ke

[17] NEMA (2007). Clean Development Mechanism (CDM) - Uganda Solid Waste Composition Project: Analysis Report-2006. State of Environment Report for Uganda 2006/2007.

[18] NEMA. (2015). The National Solid Waste Management Strategy. *National Environment Management Authority (NEMA), Nairobi*.

[19] Ojijo, A. D. (2023). Solid Waste Value Addition and Sustainable Development in Kisumu County, Kenya. *International Journal of Research and Analysis in Commerce and Management*, 2(1).

[20] Okot-Okumu, J. (2012). Solid Waste Management in African Cities. *East African Journal*. Retrieved from http//dx.doi.org/10.5772/50241.

[21] Olatubosun, A. Y., Ogungbile, P. O., Sridhar, M. K. C., & Sangodoyin, A. Y. (2023). Household Solid Waste Management Strategies in a Metropolitan Community at Orile - Agege, Lagos, Nigeria. *International Journal of Environment and Waste Management, 31*(4), 455 – 466. https://dx.doi.org/10.1504/IJEWM.2023.131245

[22] Onyango, G. M., Wagah, G.G, Omondi, L.A., & Obera, B.O. (2013). Market Places Experience from Kisumu City of Kenya. *Maseno University Press, Kisumu*.

[23] Rahman, M.Z., Siwar, C & Begum, R. (2017). Achieving Sustainable Livelihood Through Solid Waste Management in Dhaka City. *International Journal of Geomatics*. Doi:http://dx.doi.orga/10.21660/2017.30.160618.

[24] Seadi, T., Owen, N., Hellstrom, H. & Kang, H. (2013). Source Separation of Municipal Solid Waste: An Overview of the Source Separation and Separate Collection of the Digestible Fraction of Household Waste, and of other Wastes from Municipalities, aimed to be used as Feedstock for Anaerobic Digestion in Biogas Plant. *IEA Bioenergy*. ISBN978-910154-01-4.

[25] Sibanda, L.K., Obange, N. & Awuor, F. O. (2017). Challenges of Solid Waste Management in Kisumu Kenya. *Journal of Urban Forum*. DOI 10.1007/s/12132-017-9316-1.

[26] Simon, D., Arfvidson, H., Anand, G., Bazaz, A., Fenna, G., Foster, K., Oloko, M...Ombara, D.C. (2015). Developing and Testing the Urban Sustainable Development Goal's Targets and Indicators -a Five-City Study. *International Institute for Environment and Development (IED)*. DOI:10.117/0956247815619865.

[27] Sinthumule, I. N & Mkumbuzi, H.S. (2019). Participation in Community-Based Solid Waste Management in Nkulumane Suburb, Bulawayo, Zimbabwe. *Journal on Sustainability*. ISSN 2071-1050. Retrieved from https://doi.org//10.3390/resourcces 8010030.

[28] VALORGAS (2012). Institutional and Community Food Waste Generation Rates and Appropriateness of Scale for on-site Utilization for Second Generation Biofuel Production by AD. *FP7 VALORGAS Project 241334*, Deliverable http://www.valorgas.soton.ac.uk/deliverables.htm.

[29] World Bank, (2012). 'WHAT A WASTE': A global Review of Solid Waste Management. *World Bank*.

[30] Zhang, H. & Wen, Z. G. (2014). Residents Household Solid Waste Source Separation Activity: A Case Study of Suzhou, China. *Journal on Sustainability*. ISSN 2071-1050. Retrieved from www.mpdi.com/journal/sustainability.

[31] Zhou, C., Fang, X., Wang, Y., & Zhang, Q. (2022). The Influence Mechanism of Household Waste Separation Behaviour among College Students in the Post COVID-19 Pandemic Period. *Journal of Material Cycles and Waste Management, 24*, 784–800. Retrieved from http: 10.1007/s10163-022-01363-3.