

*Research article***Assessment of methods practiced in the disposal of solid waste in  
Eastleigh Nairobi County, Kenya****Joseph Muiruri<sup>1,\*</sup>, Raphael Wahome<sup>2</sup> and Kiemo Karatu<sup>3</sup>**

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**Abstract:** Solid waste management is a documented threat to health and the environment to many countries in sub-Saharan Africa. Rapid industrial development and urbanization have seen a rise in urban population which translates to massive production of solid waste. Though most urban and city planners have adopted new technologies such as landfills and incineration these alone cannot work without training residents on best practices that will guide them on how to manage their waste. Both health and environmental implications are associated with solid waste management and amounting in urgency especially in developing countries. The study aimed to assess the methods used by residents of Eastleigh South Ward in Nairobi County to dispose of their solid waste at the household level. Various waste disposal methods were documented during field observation and interviews while secondary data was obtained from records and reports on the management of waste in Nairobi County. About 48% of the resident indicated they discard waste along the road in heap/drainage, further 35% indicated putting waste in dust bins which eventually ends up in undesignated areas. The study also documents challenges related to waste management including infrequent /irregular waste collection, illegal dumping, low levels of information on poor waste disposal, and lack of concern among residents. Other challenges included irresponsible waste management approaches by the Nairobi County Government as well reluctance to pay private garbage collectors and high cost of disposal services charged by private garbage collectors. Promoting awareness through public education on the management of solid waste will enhance proper solid waste management practices. The study further recommends allocation of more resources to allow for effective management of solid waste.

**Keywords:** solid waste; disposal; environment; public awareness; practices

## 1. Introduction

Mahar et al. [1] defines solid waste as biodegradable and non-biodegradable material along with other refuse occasioned by human and animal activities which are of little value and mostly done away with. Empirical evidence from the literature on urban development show that rapid population growth has led to a massive generation of solid waste resulting from poor waste disposal systems in cities and urban areas.

According to Nabegu [2], urban waste management sector is facing numerous challenges globally especially due to the large amounts of municipal and industrial wastes produced daily. A report by UNEP [3] acknowledges that it is estimated that every year about 3.4 to 4 billion tons of solid waste and up to 300 million tons of hazardous waste are produced globally. Thus, the huge increase in the volume of solid waste will witness unprecedented scale of environmental risks such as diseases, ecosystem degradation contamination of soil and water, global warming and climate extremes. According to Ayodeji [4], the risks posed by poor management and disposal methods are more obvious in the developing countries who are the greatest consumers of industrial materials as well as outdated and obsolete technological products.

In the last two decades environmental degradation has continued to attract the attention within the global community a situation that has made more people to become increasingly conscious of variety of environmental issues such as global warming, air, water and land pollution. Most literature on environmental sustainability shows that almost all types of environmental pollution result from human induced activities. Fernando [5] believes that it is important for residents to understand the need for sustainable disposal mechanisms as a solution to the dangers posed by environmental pollution. The main purposes of Solid Waste Management strategies are to address the environmental, health, aesthetic, economic and land-use concerns attributed to improper waste disposal for nations, municipalities, corporations, and individuals around the world [6,7]. Asmawati et al. [8] argues that there is no material in this world that is not useful in one-way or the other or which is created out of nothing but it is through ignorance that man considers certain things as waste and others as useful.

Wilson et al. and Munyaga, N [9,10] opined that management of solid waste systems have resulted in major challenges for emerging cities more so in underdeveloped countries. Further, Safiuddin et al. [11] observed waste management problem continue to deepen owing to heightened human activities. Wilson et al. [12] pointed out that the main challenge with disposal of waste stems from poorly grounded strategies that occasion littering, illegal waste disposal including burning. According to Kassim S.M Ali [13] waste occasioned by human activities should be discarded to reduce risk to the environment and health of humans and animals. Further, inadequate collection of poorly disposed of solid waste results in an increase of pathogens that cause air and water-borne diseases since they play hosts to other disease vectors such as mosquitoes, flies and rodents. Kassenga et al., Omofonmwan er al. and Leah Oyake-Ombis [14–16] argued that dumpsites being the initial waste collection sources, become reservoirs of most polluting agents making them environmental polluting zones for soil, air, ground and surface water. In the last two decades, Kenya has recorded tremendous industrial development in line with the vision 2030, a situation that has seen

an influx of population to the urban centers which are likely to increase solid waste generation to higher levels, hence the need for urgent waste disposal mechanisms. Management of solid waste in urban areas of Kenya is a real challenge while the existing disposal systems are haphazard and inefficient. Otieno and Gakungu [17,18] opined that a good proportion of all solid waste generated in urban areas ranging between 30%–40% remain uncollected, while solid waste generation rate exceeds one kilogram per capita per day, [19]. Moreover, urban management bodies have failed to implement solid waste management systems that are sustainable resulting in enhanced illegal dumping in open fields that pose unfavorable effects on the environment hence negatively impacting public health systems.

Data obtained from KNBS [20] estimates that of the 47.5 million people, 34.8% translating to 10 million of the total population in Kenya are inhabitants of urban centres with the five major urban centres of Nairobi, Mombasa, Kisumu, Nakuru and Eldoret accounting for a third of the total urban population. Nairobi County's population is estimated to be about 4.3 million people who generate about 2400 tons of solid waste daily, a worrying trend and King'oo [21] observed that if proper measures for the management of waste are not put into place, this scenario will continue to foster further socio-economic, environmental and institutional challenges for Nairobi county.

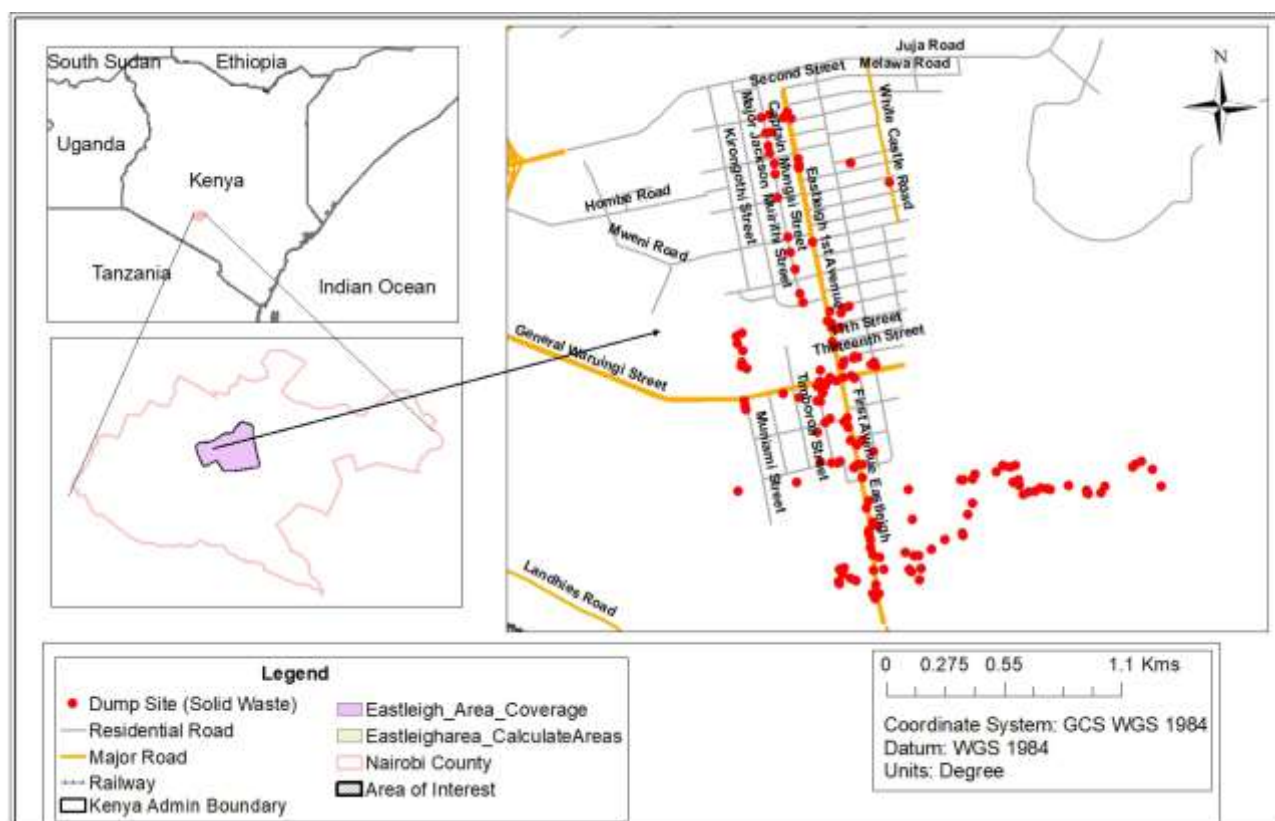
Nairobi city like some other cities in Africa lacks effective systems of solid waste management resulting in negative short and long-term impacts on human health and the environment in general [22]. According to Musyoka [23], if these challenges are not addressed by 2030 the county could generate 35% more waste than it does today. Muniafu et al. [24], observed that various legislations in Kenya mandates local authorities with the task of managing solid waste. However, the implementation of these policies and legal provisions have not been systematic and lack coordination. According to Nairobi Solid Waste Management Plan [25], of all waste generated in Nairobi 68% is domestic, making it prudent to focus on types of solid wastes generated as well as the methods used in disposing of waste by the residents.

The research was carried out in Eastleigh suburb one of the most populated zones in Nairobi County, mainly due to high influx of Somali population as well as the emergence of numerous wholesale and retail businesses. The population is a mix of middle and low-income neighbourhoods. 1<sup>st</sup> Avenue the main street in Eastleigh has buildings with multiple uses such as business malls, with the basements used as storage facilities, while the upper floors have been converted into residential areas. Further, open spaces are used as open-air garages, parking lots while the alleys and pedestrian walks are used by small scale traders and hawkers selling all sorts of goods such as clothes, shoes, electronics as well as vegetables and fruits. The activities carried out have led to generation of high volumes of solid waste which is poorly stored and disposed posing a serious public health and environmental hazards. Residents' behavioural practices towards generation, handling and disposal of solid waste is wanting because they use unorthodox methods disposing of waste anywhere they find convenient irrespective of whether it is a designated site or not. A big percentage of waste is discarded along the road, in open spaces and drainage channels. The study sought to answer the research question; What are the methods used by the residents in solid waste management in Eastleigh Nairobi County? The study was premised on the researcher's hypothesis that methods of solid waste adopted by residents of Eastleigh in Nairobi County are poor.

## 2. Materials and method

### 2.1. Study site

This research was carried out in Eastleigh South Ward within Kamukunji Sub-County in Nairobi County, Kenya. The area of study is situated in the eastern part of Nairobi city at geographical coordinates of; 1.2734 S, 36.8481 E. The study area is cosmopolitan and is one of the busy commercial hubs of Nairobi County. Many of the businesses are owned by the Somali community.



**Figure 1.** Map of area of study.

### 2.2. Sample size and sampling

Eastleigh South Ward is within Kamukunji Sub-County, Nairobi County which covers an area of 12 square kilometres carrying a population of 263462 persons. Eastleigh South Ward the main focus of the study covers approximately 4.02431 square kilometres carrying a population of 89968 persons and an estimated 29022 households. The area has an average household size of 3.1 persons spread over 10.552 square kilometres. For the study a sample size of 188 households was derived which was rounded up to the nearest hundred to a sample size of 200 households using the formula below;

$$n = \frac{(z^2 \times p \times q \times N)}{e^2 (N - 1) + (z^2 \times p \times q)}, \text{ where:}$$

$n$  = Sample size (being determined)

$N$  = Population size (29022)

$p$  = Sample proportion (assumed to be 0.02, if not given)

$$q = 1 - p$$

$e = 0.02$  (since the acceptable error should be 2%)

$z$  = Standard deviation at a given CI ( $z = 1.96$  at 95% CI)

### 2.3. Data collection

Primary data was collected through random sampling targeting households within the area of Study from April through to May 2019. Quantitative data was obtained through use of numeric data (outline) that is measurable while the qualitative method involved both descriptive and conceptual data (outline) to provide in-depth information. Data collection involved use of questionnaires, interviews, field observation and document analysis. The study used a face to face interview with respondents and key informants from randomly selected households, shop attendants, street vendors and hawkers. The questionnaires employed involved both structured and semi-structured questions to gather more data from the respondents on methods used to manage generated waste. Sampled households were picked depending on accessibility, availability and willingness of the respondents to participate in the survey while secondary data was obtained through a review of census and survey reports as well as previous research studies on the management of solid waste. Further, field observations documented important information on modes of waste disposal through the use of Figure 2, 5 and 7 and physical observation. Mixed methods approach enabled the researcher to cross-check the data to enable valid and credible results [26].

### 2.4. Data analysis

Both quantitative and qualitative data obtained from questionnaires and interviews were coded and analyzed using Statistical Package for Social Sciences (SPSS) version 21.0. Descriptive statistics were obtained and presented in frequencies and percentages for the following variables; methods, waste composition, level of solid waste, waste storage and demographic characteristics. The study assessed the relationship between household demographic characteristics and management of solid waste practices using cross-tabulation and chi-square analysis at a significance level of less than 5%.

## 3. Results and discussion

### 3.1. Sample distribution

According to population studies, demographic characteristics consist of age, family size, material status, education level and income, which according to Castagna et al. and Chu et al [27,28] are critical when dealing with the evaluation of the management of solid waste practices within populations. The demographic characteristics of the respondents are presented in Table 1, where 57.6% male and 42.4% female with a mean age of 25–34 years were interviewed. Of these about 55.1% were married. On education, the majority had attained secondary level (55.9%) while (35.6%) had middle-level college education. Slightly less than half of the individuals (43.2%) had a monthly income of between Ksh. 10000–20000.

**Table 1.** Responses to demographic characteristics.

Demographic characteristics			Male	Female	Total
Age group	18–24 Years	N	17	15	32
		%	14.40%	12.70%	27.10%
	25–34 Years	N	26	23	49
		%	22.00%	19.50%	41.50%
	35–44 Years	N	15	5	20
		%	12.70%	4.20%	16.90%
	45–54 Years	N	9	6	15
		%	7.60%	5.10%	12.70%
	Over 55 Years	N	1	1	2
		%	0.80%	0.80%	1.70%
Marital status	Total	N	68	50	118
		%	57.60%	42.40%	100.00%
	Married	N	36	29	65
		%	30.50%	24.60%	55.10%
	Single	N	29	16	45
		%	24.60%	13.60%	38.10%
	Separated	N	1	3	4
		%	0.80%	2.50%	3.40%
	Widowed	N	2	2	4
		%	1.70%	1.70%	3.40%
Education level	Total	N	68	50	118
		%	57.60%	42.40%	100.00%
	None	N	1	0	1
		%	0.80%	0.00%	0.80%
	Primary	N	5	4	9
		%	4.20%	3.40%	7.60%
	Secondary	N	38	28	66
		%	32.20%	23.70%	55.90%
	College	N	24	18	42
		%	20.30%	15.30%	35.60%
Monthly income	Total	N	68	50	118
		%	57.60%	42.40%	100.00%
	<Ksh. 10000	N	14	5	19
		%	11.90%	4.20%	16.10%
	Ksh. 10000–20000	N	28	23	51
		%	23.70%	19.50%	43.20%
	Ksh. 20000–50000	N	21	21	42
		%	17.80%	17.80%	35.60%
	Ksh. 50000–100000	N	5	1	6
		%	4.20%	0.80%	5.10%
Total	Total	N	68	50	118
		%	57.60%	42.40%	100.00%

### 3.2. Responses to the composition of solid waste

Much of the waste generated within the area is organic (51.5%) and the other half is inorganic (48.5%) (Table 2). The study identified packaging materials are increasingly becoming a critical component of solid waste as earlier observed by Firdaus et al. [29] who contends that as the gross national product and urban population growth rises, paper and packaging waste will also increase. Ampofo et al. [30] contends that food-stuffs waste is greatly produced at the stage of wrapping, preparation and use. A variety of containers used for wrapping most items for sale is dumped in the environment, this has led to the development of many illegal dumpsites which creates unhealthy environment and blockage of sewerage systems resulting in flooding especially during the rainy season.

As a result, a substantial amount of the waste within the designated collection sites remained uncollected which accumulate into filthy huge moulds that negatively impact on the quality of air in the surrounding neighbourhoods.



**Figure 2.** A heap of solid waste along 1st Avenue, Eastleigh.

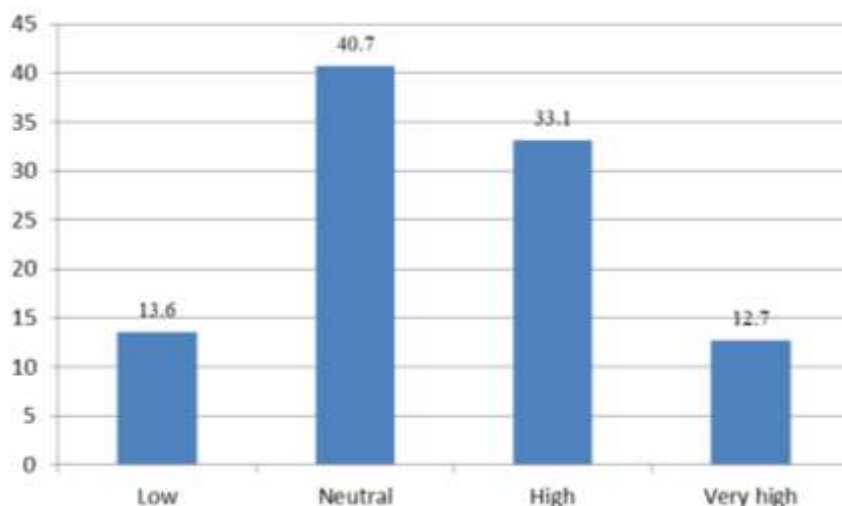
**Table2.** Responses on the composition of solid waste.

Type of waste	Number of persons in a household			Total
	<3	4–6	7–9	
Organic waste	(56) 47.8%	(63) 53.2%	(65) 55.0%	(61) 51.5%
Inorganic waste	(62) 52.2%	(55) 46.8%	(53) 45.0%	(57) 48.5%
Total	(118) 100.0%	(118) 100.00%	(118) 100.00%	(118) 100.00%



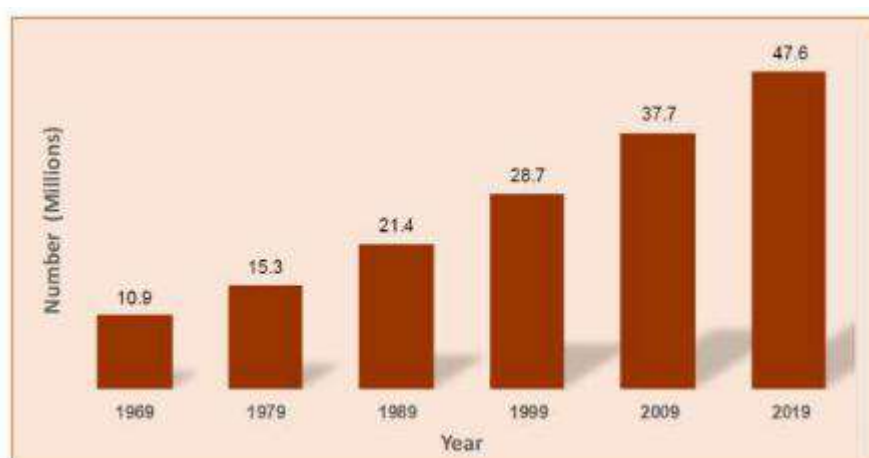
### 3.3. Levels of solid waste generated

The study sought to rate the level of waste generated from respondents. Figure 3 indicates how respondents rated the levels of waste in their residential area. 40.70% reported that the levels were neutral with 33.10% indicating levels were high while only 12.70% said the levels were very high.



**Figure 3.** Responses on the level of waste generated.

With the rapid increase of population from natural causes and rural-urban migration, waste generation has increased tremendously much of which is poorly handled ending up in undesignated dump sites. In a study by Dhamija [31], India in 2001, the population in the urban areas had increased to 93.0% from 52.7% in 1901. This led to a significant increase in solid waste in urban areas resulting in a hazardous dimension. The waste estimate generation increased from 4500 Metric Tonnes/day (MT/day), 6,500 MT/day to 12000 MT/day in the year 1981, 1991, and 2001 respectively. This is expected to rise to 17000–25000 MT/day by 2021 with assumption of 6–8% growth rate. In Kenya, there is a similar situation of population increase where from 1969 to 2019 the population has grown from 10.9M to 47.6M (Figure 4) with about 26.3% population increase from year 2009–2019 [20].



**Figure 4.** Population trend, 1969 to 2019 [20].



During the field visit (Figure 5) observations showed waste was usually disposed unsorted in heaps in undesignated areas. According to Firdaus et al. [29], waste generated is drastically increased when relevant agencies charged with collecting and disposing are unable to deal with the large quantities produced on daily basis. This results in the accumulation and rotting of uncollected garbage at collection sites.



**Figure 5.** Solid waste dumped on the road (Eastleigh 2nd Avenue).

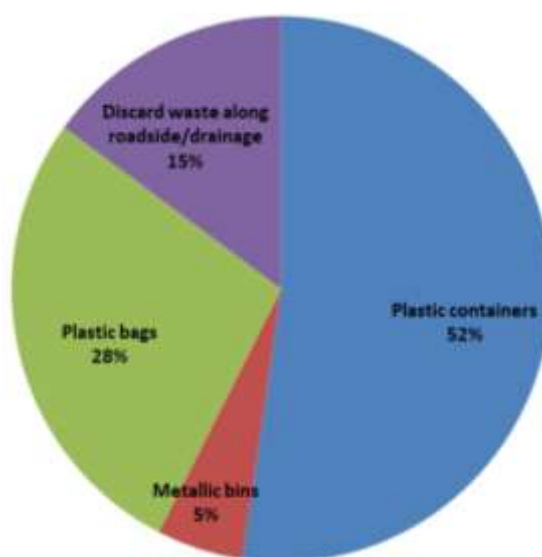
#### 3.4. *Storage and collection*

The study investigated types of containers used for storage and collection of waste in Eastleigh suburb. Figure 6 highlights the responses to the study question. Responses revealed that containers made of plastic (bags and buckets) were the most preferred at 52% and 28% respectively; evidently these are the most commonly used. The study observed that 15% of the respondents discarded their waste in undesignated areas such as roadsides and drainage tunnels with a paltry 5% storing their waste in covered bins. However, the study observed that though some respondents stored their waste in plastic buckets, plastic bags and metallic bins, most of this waste was disposed at the undesignated dumping sites as shown in the Figure below. The haphazard dumping of solid waste in open spaces are a great risk to the environment as it leads to air, water and land pollution.

#### 3.5. *Solid waste disposal management*

Regarding solid waste disposal management, 31.8% indicated that residents within the area managed collection and disposal by enlisting private garbage collectors. However, 68.2% indicated they are not involved in any form of management of solid waste services, resulting in most of the generated waste being poorly disposed. The respondents indicated that while some residents paid for the services by private service providers, others opted to take their waste at designated garbage collection points where it is collected at specific times by the County Government garbage trucks. The study was able to identify other waste disposal options available to the residents. A good number (48.0%) opts to discard waste along the road, in the drainage channels and other undesignated points with 25.1% indicating they stored waste in dustbins which they eventually took to designated

collection points. A small number of residents (4.7%) prefer storing waste in dustbins and later empty it in the county skips usually found in designated sites within the area, with only (8.8%) preferring burning, nature of waste notwithstanding. Out of the total number of respondents interviewed only 3.5% indicated that they recycled some of the waste (Table 3). The study also established waste collection intervals ranged between once a week at 61.0%, twice a week at 28.8% while 3.4% indicated that waste was irregularly collected. However, 5.1% of the respondents indicated waste is never collected at all (Table 3).



**Figure 6.** Responses on methods used in waste storage.

**Table 3.** Responses to methods of waste disposal and collection frequency.

Methods of disposal	N	%	Frequency of collection	N	%
Discarding along the road in a heap/drainage	82	48.0	Once a week	72	61.0
Putting in a dust bin	60	35.1	Two times a week	34	28.8
Burning	15	8.8	Everyday	2	1.7
Disposing at designated collection points	8	4.7	Irregular	4	3.4
Recycling	6	3.5	Zero collection	6	5.1
Total	171	100.0	Total	118	100

Evidence from field observation reveals that most respondents at 61.0 % discard their wastes in drainage channels and by the roadside. This is occasioned by a haphazard manner of waste collection by private waste collectors and Nairobi County government. Waste stored in dustbins ends up being discarded on the roadside or in drainage channels since some residents default on payment to service providers while others cannot afford it. When the discarded waste piles up some residents result in burning affecting the air quality within the vicinity an argument supported Giusti [32] who contends that continuous burning of solid waste in the open causes health problems to those exposed to inhalation of the ambient gases released into the air and in turn leads to respiratory and eye problems.



**Figure 7.** Burnt solid waste off 2nd Avenue, Eastleigh.

According to Ampofo S et al. and Leah Ombis [16,30] several issues identified that rendered solid waste unmanageable, include; resident's reluctance to pay for private service providers, inefficiency over waste collection and disposal services by the relevant county authority, inadequate public awareness and unreliable means of transporting waste to Dandora landfill. For Giusti [32], to overcome these challenges, Nairobi county government should adopt sustainable management of solid waste including but not limited to waste minimization/prevention, waste re-use, recycling and composting. Ampofo et al [30] further argues that waste that is not recyclable, reused or composited other methods such as incineration and landfilling processes can be adopted. In Denmark, Sweden, Netherlands and Austria for instance, organic waste is not subjected to incineration due to its high-water content rather, separation of waste at the source allows removal of hazardous waste, complementing composting and recycling options 4 [33]. It is instructive that more information on alternative sustainable management methods of solid waste is key to achieving sustainable, clean and safe environment.

### *3.6. Reasons for poor solid waste disposal*

Un-Habitat [34] report on sustainable cities, has identified poor management of solid waste as a major challenge towards the promotion of a sustainable environment and livelihoods. Table 4 highlights responses on the challenges affecting the management of solid waste in the studied area with 37.2% indicating that they were not bothered by the state of poorly disposed waste, 16.8% identified lateness of service providers in waste collection, 12.4% cited lack of information on appropriate waste management methods while 5.8% indicated reluctance in paying service providers fee with another 9.5% identifying inefficiency by the Nairobi county government as the main

challenge. 5.1% indicated high charges of waste collection fee and poor cooperation among residents and service providers as the reason for poor management in waste disposal.

**Table 4.** Responses on reasons for poor management of solid waste in Eastleigh.

Reasons for Poor Management of solid waste	N	Percent
Lack of concern	51	37.2%
Lateness in the collection of waste	23	16.8%
Reluctance to pay private waste collectors	8	5.80%
High charges of waste collection	7	5.10%
Poor cooperation among residents and private waste collectors	7	5.10%
Lack of appropriate information on the management of waste	17	12.40%
Failure by Nairobi County Government to take their responsibility seriously	13	9.50%
Poor transportation	1	0.70%
Poor storage	2	1.50%
Informal settlements	6	4.40%
Poorly managed collection points	1	0.70%
Increase in population	1	0.70%
Total	137	100.0%

Findings conclude that lack of concern by residents on good management practices of solid waste has led to negative impacts on solid waste disposal damaging the environment. Ampofo et al. opines that some residents shun appropriate management methods of waste to avoid meeting the costs of service providers. Further Findings indicate that some residents decry the services rendered by private collectors as unsatisfactory owing to delays and irregular collection hence the unwillingness to pay, leaving them with no choice but to use unorthodox means of disposing waste [30], citing UN-Habitat Report [34], argues that the generation of waste is inevitable due to the rapid increase in urban population, hence the need for concerted efforts by national governments and urban authorities in the development of sustainable cities. According to Tiwari [35], though most urban authorities developed environmental policies and legislation, implementation remains a pipe dream. To address these challenges Boadi et al., Parrot et al. and Henry et al. [36–38] highlights the need to adopt sustainable management strategies to enable address negative consequences related to the unregulated management of solid waste practices.

#### 4. Conclusion

After careful analysis of the data gathered it is imperative to conclude that uncollected solid waste has become the most visible environmental problem particularly among the low and middle-income neighborhoods within Nairobi's Eastleigh South Ward. This scenario is supported by Leah O. Ombis [16], that Nairobi city county government waste management system is fraught with many problems and has no clear systems and process to deal with an estimated 2400 tons of waste generated daily. The study was able to identify the challenges that Eastleigh residents experienced in regard to solid waste disposal and collection systems. Various challenges were identified which include; failure by the county government authority to prioritize implementing various guidelines and legislation on waste management, inefficiency in waste collection and poor infrastructure. In addition, activities of multiple actors involved are poorly coordinated, while in some sections of the

area of study, waste collection systems are non-existent and even where services are found, they are riddled with many challenges that include residents' inability to pay.

## 5. Recommendations

Nairobi County Government should enforce existing management of solid waste policies and legislations as spelled out in Environment Management and Coordination Act 2019, the Kenyan Constitution (2010) [39] and in the Nairobi county solid waste management Act 2015. Nairobi County government should engage other stakeholders in sensitizing residents on sustainable management systems on the solid waste that include separation, reuse and recycling. Nairobi county government should institutionalize management of waste processes by investing in efficiency and infrastructural capacity by providing skips, trucks, bins, as well as guidelines on modalities to service providers on proper waste Management. The findings of the study can be replicated in other urban centres of developing Countries. This would help mitigate environmental issues associated with poor waste management systems.

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## Conflict of interest

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

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