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Evaluation of Solid Waste Produced in Garowe District Somalia

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ABSTRACT

Historically, waste management in Garowe District was marked by traditional practices driven by necessity rather than environmental consciousness, the aim of the study was to evaluate solid waste produced in the district while the specific objectives were to identify the composition and quantity of biodegradable waste generated the Garowe District, to assess the types and quantities of non-biodegradable waste produced in Garowe District and also To evaluate the existing waste management practices in the district. The study employed mixed methods. Copies of questionnaires were administered to 388 households and interviews conducted with 5 key informants to assess solid waste composition, quantities, handling practices, and management gaps. The study found food scraps constitute the majority of biodegradable waste generated in households, while plastics dominate the non-biodegradable waste stream. On average, household waste generation exceeds 1 kg per day, and municipal collection services only reach a portion of district residence. Existing waste management efforts focus primarily on collection and disposal with minimal infrastructure for material recovery, recycling or composting. While most residents express willingness to separate organic waste, few households implement home composting due to knowledge gaps and space constraints. The findings reveal significant potential to improve waste management sustainability by reducing disposal volumes and introducing programs to divert organics and recyclables from dumping sites. Key recommendations include public education, expanding source segregation, constructing composting and recycling facilities, and better integrating the informal recycling sector. The study provides important baseline data to inform integrated municipal solid waste management planning aligned with local needs while minimizing environmental and public health impacts.

KEY WORDS: Waste management, Garowe District, Municipal solid waste, Household waste, Somalia

INTRODUCTION

The study focuses on the historical, theoretical, and conceptual perspectives of waste management in Garowe District. Historically, waste management in Garowe District was marked by traditional practices driven by necessity rather than environmental consciousness. Open dumping was a prevalent practice. This method, while convenient in the short term, led to the pollution of soil and water sources, posing significant health risks to the community [1]. Burning of waste, another common practice, was undertaken to reduce the volume of waste. However, this method released harmful toxins into the air, further deteriorating the air quality and overall environmental health [2]. These practices are not only hazardous to the environment but also to the health of the people living in Garowe District, as exposure to open dumps and burning waste could lead to various respiratory diseases and other health issues. Urbanization and population growth exacerbated these challenges. As the population increased, so did the volume and diversity of waste [3]. With limited awareness and education about proper waste management, the community continued to dispose of waste without segregation, resulting in mixed waste streams that were difficult to handle and recycle [4]. Learning from these historical challenges can inform the development of new strategies, policies, and infrastructures that address the specific needs of Garowe District in managing both biodegradable and non-biodegradable waste [5]. Globally, municipal solid waste generation is rapidly increasing, posing challenges for sustainable management. Biodegradable waste like food and yard waste and non-biodegradable waste like plastics and electronics require different handling methods to minimize environmental and health impacts [3]. The theory of reuse, pioneered by Martin Medina, offers a decentralized, community-based model to extract maximum value from discards through labour-intensive successive reuse, repair, and remanufacturing before final recycling or disposal [6]. In Somalia, protracted conflict has severely disrupted waste management systems and infrastructure, necessitating accessible localized solutions [1]. Applying principles of the theory of reuse such as decentralized collection networks, integration of informal waste pickers, and community composting can help build resilience through livelihood generation and waste diversion in the Somali context [7]. Specifically, in Garowe District, increasing municipal waste generation coupled with inadequate solid waste management poses pressing challenges [4]. The theory of reuse suggests community-based waste management cantered on source separation, collection, and successive reuse of biodegradable waste through composting and non-biodegradable waste through repair and remanufacturing at the local level [8]. This creates value, livelihoods, and environmental sustainability. The theory of reuse was developed by scholar Martin Medina in the late 1990s based on research on informal recycling systems in developing countries. It provides an alternative to centralized, capital-intensive recycling models common in industrialized nations [9].A key principle is integrating marginalized informal waste workers into authorized recycling and reuse systems [10] The theory also complements recycling by prioritizing prolonged reuse and refurbishment to extract optimal value before materials are finally recycled [11]. It aligns with circular economy principles of retaining materials locally through repeated reuse, remanufacturing, and open material cycles [12]. Major benefits of the theory of reuse include livelihood generation through labour-intensive handling, improved resource efficiency and waste reduction through prolonged product lifetimes [13], environmental protection by diverting materials from landfills [14], social inclusion of waste pickers [15] and building local economic resilience by maintaining the value of discarded materials [5]. Solid waste refers to any discarded or unwanted solid or semi-solid materials resulting from human and animal activities. It is any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities [16]. Any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, paper and paperboard. Biodegradable waste typically includes materials such as food scraps, yard trimmings, paper, and certain types of textiles. These materials can decompose naturally in the environment, often within a relatively short period under suitable conditions. On the other hand, waste which cannot be transformed through biological processes is called non-biodegradable waste [17]. Non-biodegradable waste includes materials such as plastics, metals, glass, and certain synthetic textiles. These materials persist in the environment for extended periods, often hundreds or thousands of years, without significant degradation. The management of non-biodegradable waste poses significant environmental challenges due to its long-lasting nature and potential to accumulate in ecosystems. The escalating production of both biodegradable and non-biodegradable waste poses a pressing challenge in Garowe District. Current waste management practices are inadequate, resulting in improper disposal, environmental degradation, and health risks for the residents. The indiscriminate disposal of waste, particularly non-biodegradable materials like plastics, can lead to environmental degradation, contaminate soil, water bodies, and natural habitats, harming ecosystems and biodiversity. Improper waste management can also create breeding grounds for disease-carrying vectors, release toxic substances and pollutants into the environment, posing health risks to the local population. Lack of efficient waste segregation, limited recycling infrastructure, and insufficient public awareness exacerbate the issue. Conducting a systematic evaluation will help understand the scale of the problem and identify priority areas for intervention. The findings can guide policies and programs to improve segregation, optimize, promote recycling and safe disposal, and build sustainable waste management capacity in the district. The study aimed to evaluate solid waste produced in Garowe District.

Geographical scope of the study

The study was conducted in the Garowe district, the administrative capital of Puntland, Somalia's Nugal region. The district is situated in the Nugal Valley, surrounded by high plateaus that can reach elevations of 500 to 1,000 meters. Located in the center of Puntland, in north-eastern Somalia, is Garowe. East Gillab (4.8 nm), northeast Qalqalooc (15.3 nm), north LibaaxSeexay (2.5 nm), northwest GeidaDebabo (12.2), west Bixin (5.9 nm), southwest Lugo (6.0 nm), south Salaxley (5.3 nm), and southeast War Weytan (9.7 nm) are some of the nearby settlements. Nearest major cities to Garowe are Qardho (205 km), Erigavo (275 km), and Galkayo (216 km). (Maps by Google, 2023)

Content scope of the study

The economy is based on cattle raising, with wild trees harvested for myrrh and frankincense. The study aims to assess the types, quantity, and management practices of solid waste produced in the Garowe District, focusing on biodegradable and non-biodegradable waste. The study will evaluate solid waste produced in the Garowe district.

Time scope

The study was conducted over a period of approximately 6 months, from January 2024 to June 2024. It included 2 months for background research, tool development, and field preparation, followed by 3 months of intensive data collection and analysis. The final month was devoted to report writing, validation, and dissemination of findings.

Area and Location

The study was conducted in Garowe district, Somalia.The capital city of Puntland, a semi-autonomous region in north-eastern Somalia. Garowe, as an urban centre, faces various environmental challenges, including solid waste management.

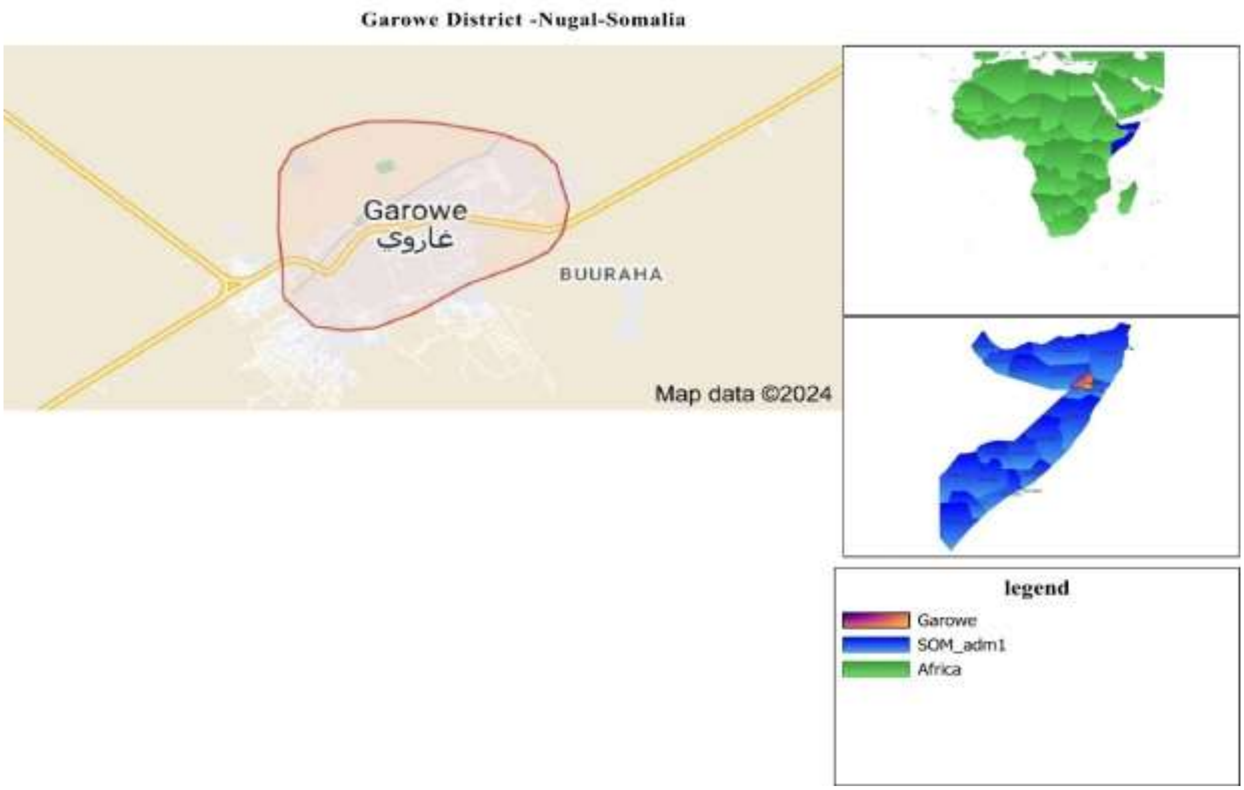

Figure: 1 map showing the study area
Source: ***google maps (2024)***

Research Design

The study employed a descriptive research design, which is not cost effective and does not require a lot of time. The researcher also adopted both quantitative and qualitative approaches to collect data from the different respondents of the study [18].

Study Population

The study population was comprised residents, local authorities, and waste management service providers in Garowe District. These groups were purposefully chosen to provide a comprehensive understanding of volume and types of waste generated in Garowe district. Garowe has a total population of 187,000 residents [19].

Sample Size

A subset of this population was selected for this research out of the total target population **187,000** [19], only **400** respondents were considered for the study. These include residents of Garowe district local authorities and waste management service providers. This number was arrived at empirically by use of the Slovene's Formula.

Table 1: Population and Sample size

Category	**Population**	**Sample**
Local Residents	186,950	370
Local authorities	25	15
Waste management service providers	25	15
Total	187,000	400

Sampling Technique

A combination of purposive and random sampling techniques was used in this study. Purposive sampling was employed to select key informants from local authorities and waste management service providers, while simple random sampling was used to select residents to ensure fair representation.

Data Collection Instruments

Questionnaire

The questionnaire was distributed in two formats: hard copies were handed out directly to the target respondents, while soft versions were created using Google Forms and shared with selected respondents via a link. The instrumental questions are comprised of two primary components. The first portion of the study focuses on gathering demographic characteristics and profile information from the participants. The second part consists of closed-ended questions designed to collect independent and dependent variables, specifically geared at measuring perceptions. The research used three types of measuring scales: interval, nominal, and ordinal scales. An interval scale of measurement is defined by ordered intervals of equal length, with an arbitrary zero value. A nominal scale of measurement is used for categorical data, while an ordinal scale of measurement is used for categorical data that contain ranks and ordered values.

Interview

The researcher also used interview guide in data collection. The questions for the interview were open-ended. The open-ended questions gave chance to more discussions. The interview guide helped to collect information from waste management companies and local government workers and environmentalists. The data was attained through on-spot questions to enable attainment of data to supplement the study.

Validity Test

Validity pertains to the degree to which data precisely represents what it is intended to represent. A significant amount of work was used to establish a coherent connection between the questions in the questionnaire and the purpose of the research. The researcher used the following formula to ascertain the validity of the research tools, as shown below.

Content Validity Index (CVI) = CVI =

If the overall Content Validity Index (CVI) of the instrument is equal to the average acceptable Index of 0.7 or above, then the instrument is accepted as valid [20].

Reliability Test

A reliability test was undertaken to determine the degree of dependability of the study. Cronbach's alpha is a statistical measure of reliability that quantifies the extent to which items in a test or questionnaire are positively associated with each other. A greater value of Cronbach's alpha indicates a stronger level of internal consistency dependability.

Data analysis

The data acquired from the respondents were inputted into a computer and processed using the statistical software SPSS Version: 20. This software helped to summarise the coded data and speed up the data analysis process. The data obtained from the surveys was meticulously examined, condensed, and interpreted using descriptive statistics. The descriptive statistics include frequencies, valid percentages, means, and standard deviation.

Ethical considerations

In order to uphold ethical standards in the study, the researcher obtained an introductory letter from the School of Natural and Applied Science (SONAS) at Kampala International University. Additionally, the researcher personally introduced themselves to pastoralists, environmental activists, community leaders, farmers, and other relevant entities, including law enforcement officers. The researcher sought input from scholars and law enforcement officials during the duration of this study. The researcher adhered to ethical guidelines in order to uphold and prevent any violations of the privacy of the respondents. This included principles of respect, secrecy, and participant autonomy.

RESULTS

Table 2: Response Rate

Sample Size	Actual returned	Percentage
400	388	97%
7	5	71.4%

Table 2 shows a response rate of 97% from the questionnaires that were administered to the respondents and 10 (66.7%) responses from the interviews

Table 3: Demographic traits of Respondents

Gender	Frequency	Percent
Male	224	57.7
Female	164	42.3
Age		
20-29 Years	162	41.8
30-39 Years	100	25.8
40-49 Years	85	21.9
50 years above	41	10.6
Academic qualification		
Certificate	76	19.6
Diploma	66	17.0
Degree	148	38.1
Post Graduate	98	25.3
Marital Status		
Single	144	37.1
Married	145	37.4
Separated/divorced	64	16.5
Widowed/widower	35	9.0
Occupation		
businessman/women	82	21.1
civil servant	128	33.0
farmer	46	11.9
none	132	34.0
H/Number of the individuals		
1-3	77	19.8
4-6	132	34.0
7-9	94	24.2
10+	85	21.8
Total	**388**	**100.0**

Table 3 reveal that the majority of respondents were male 224(57.7%) while the female was 164(42.3%). It also showed that the majority of respondents in the study were between the ages of 20-29 who was 162 (41.8%), 30-39 years 100 (25.8%), 40-49 years were 85 (21.9%), 50 years above were 41(10.6%) of the respondents. Majority of the respondents for the study were bachelor degree holders constituting 148 (38.1%) followed by post-graduate holders who were 98(25.3%), then certificate holders were 76(19.6%) respondents and finally were diploma holders 66(17.0) were respondents. Equally, majority of the respondents in the study was married constituting 145(37.4.9%), followed by single respondents who were 144(37.1%) those who separated/divorced were 64 (16.5%) and finally 35(9.0%) were widowed/widower.

Table 4 Types of biodegradable waste households generate in Garowe district, Somalia.

Responses	Frequency	Percent
food scraps	236	60.8
yard waste	82	21.1
paper	34	8.8
wood	36	9.3
Total	**388**	**100.0**

Table 4 reveals that the most common type of biodegradable waste generated by the household each week was food scraps, which accounted for 236 (60.8%) responses of the total. Yard waste was 82 (21.1%) paper waste accounted for 34 (8.8%) and wood waste represented 36 (9.3%).

Quantity of biodegradable waste households generate every week in Garowe district, Somalia

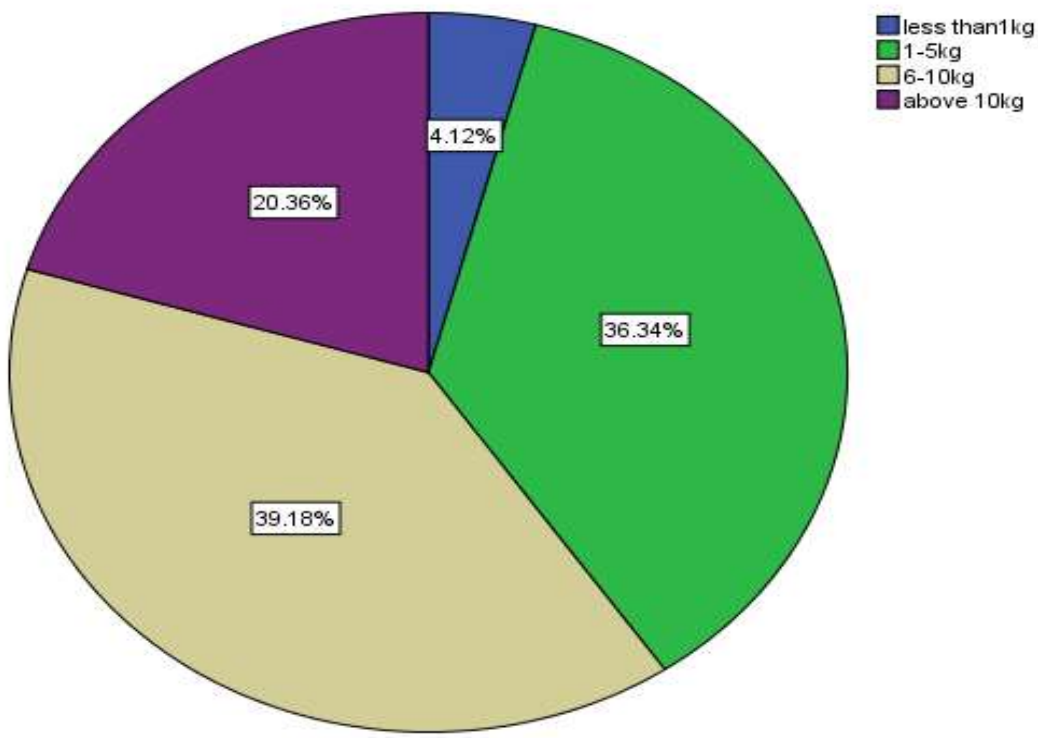

Figure 2 reveals the quantity of biodegradable waste generated per week by survey respondents' households. The most common response was 6-10kg per week, 152 (39.2%.) respondents, then second was 1-5kg per week, 141(36.3%) respondents also 79(20.4%) respondents generated over 10kg per week, and finally just 16(4.1%) respondents generated less than 1kg per week. The study indicates, the majority of households generated 1-10kg of biodegradable waste per week, it also indicates most households generate a substantial quantity of biodegradable waste weekly.

Households compost of biodegradable waste in Garowe district, Somalia

Figure 3 Response of Household Separation of non-biodegradable waste for recycling/reuse

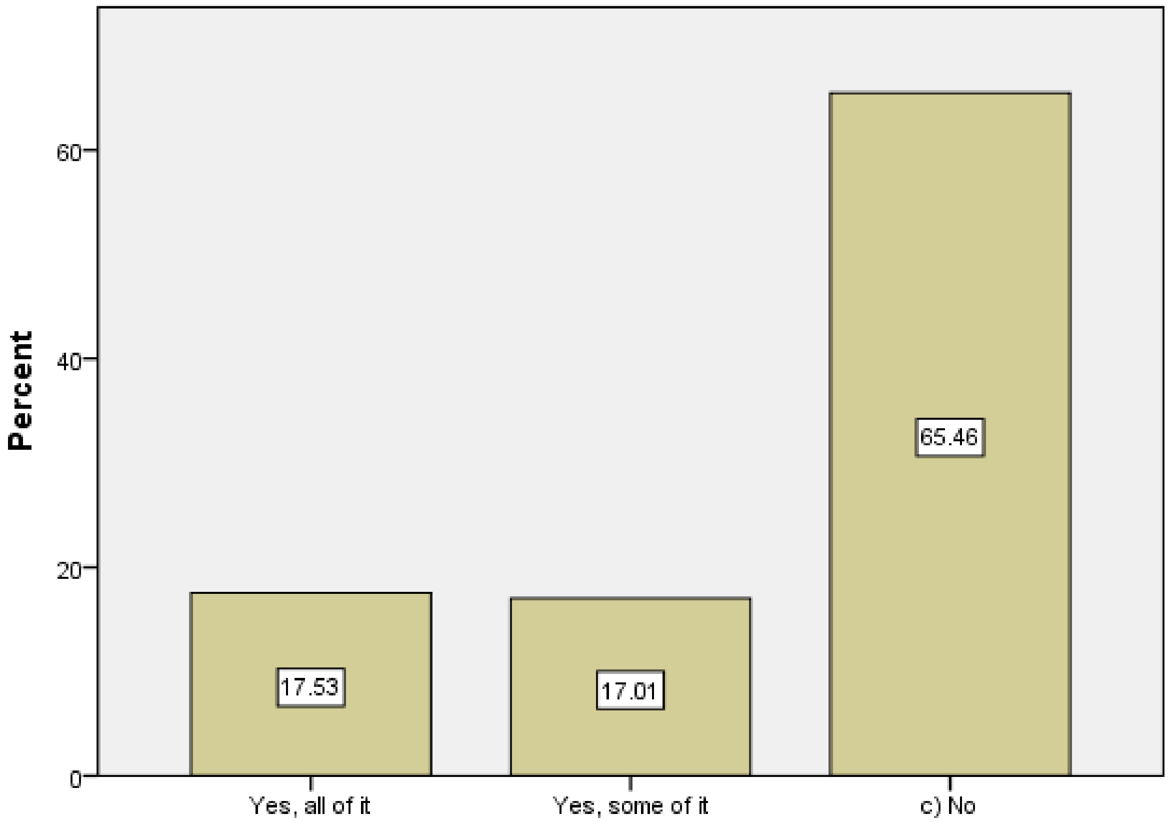

Figure 3 shows that the majority of respondents 254(65.5%) reported that they do not compost any biodegradable waste. Only 134(34.5%) of respondents said they compost some or all of their biodegradable waste - specifically, 68(17.5%) compost all of it while 66(17%) compost some of it.

Table 5: Methods used for composting in Garowe district, Somalia.

Responses	Frequency	Percent
Pile composting	57	14.7
Pit composting	77	19.8
Total	134	34.5
Missing system	254	65.5
Total	**388**	**100.0**

Table 5 shows that of the 388 total responses, 134 (34.5 %) provided information on their composting method. Among those who compost, 57(14.7%) responses use pile composting, while 77(19.8%) responses use pit composting. The remaining 254(65.5%) responses did not specify a composting method, which were categorized as missing system. The research indicates that among the 134 responses who do compost biodegradable waste, approximately 43% percent use pile composting and 57% percent use pit composting, according to the frequency and percentage data provided in the table the study also indicates that most of them did not compost the biodegradable waste.

Table 6: Barriers that make it difficult to compost biodegradable waste in Garowe district, Somalia

Responses	Frequency	Percent
Lack of space	120	30.9
Lack of knowledge	215	55.4
Takes too much time/effort	53	13.7
Total	**388**	**100.0**

Table 6 shows the most commonly cited barrier was a lack of knowledge about composting, with 215(55.4%) by a lack of space for a compost pile or bin, with 120(30.9%). The least common barrier identified in the survey was that composting takes too much time and effort, which was only mentioned by 53(13.7%) respondents.

Table 7: Types of non-biodegradable waste do your household generate each week in Garowe, district Somalia

Responses	Frequency	Percent
Plastics	133	34.3
Glass	50	12.9
other metal	102	26.3
Electronics	69	17.8
other	34	8.8
Total	**388**	**100.0**

Table 7 shows that 133 (34.3%) of respondents reported their household generates plastics waste each week then glass waste is generated by 50(12.9%), also 102 (26.3%) said their household produces other metal waste, and 69 (17.8%) respondents generate electronics waste weekly. Only 34(8.8%) indicated their household creates other types of non-biodegradable waste each week.

Figure 4: Estimated amount of total non-biodegradable waste household generates each week

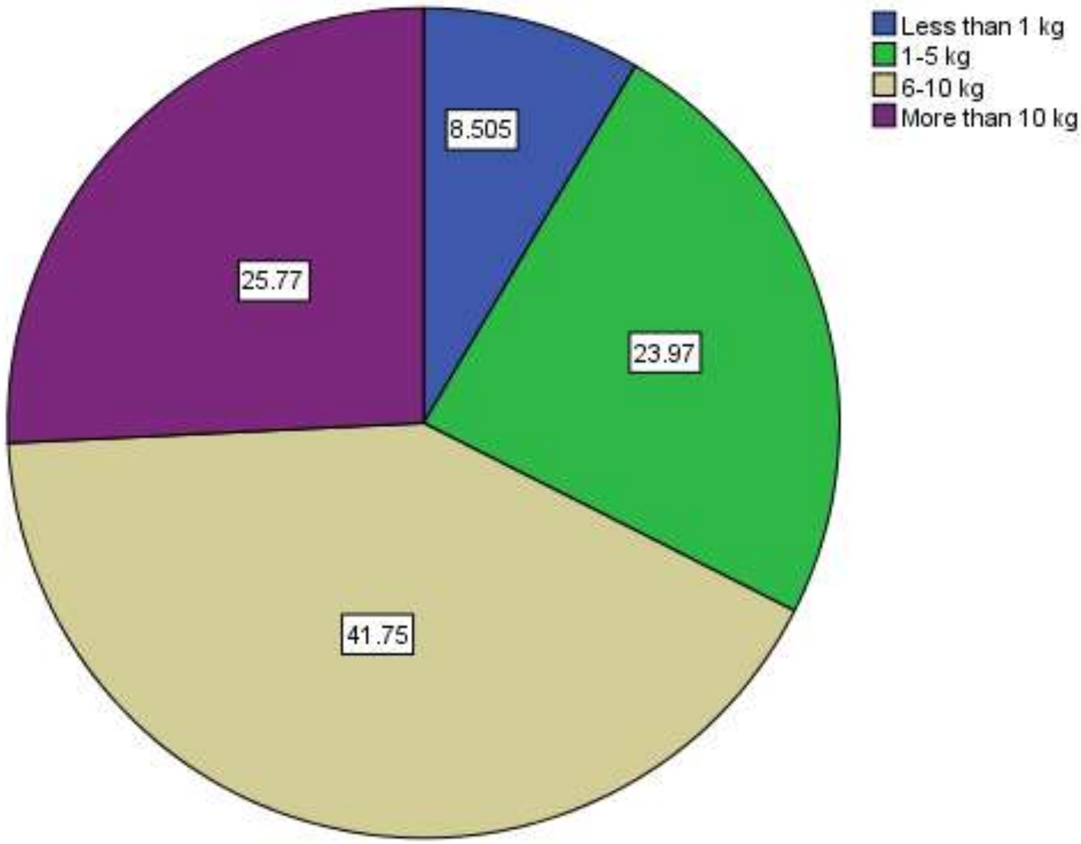

Figure 4 shows the estimated amount of total non-biodegradable waste households generate each week in Garowe district, Somalia The most common response was 6-10kg per week, selected by 162 (41.8%.) out of 388 respondents followed by 1-5kg per week, chosen by 93 (24%) respondents. 100 respondents (25.8%) estimated their households generate more than 10kg of non-biodegradable waste weekly, while 33 respondents (8.5%) estimated less than 1kg per week.

Figure 5: Response of Household Separation of non-biodegradable waste for recycling/reuse

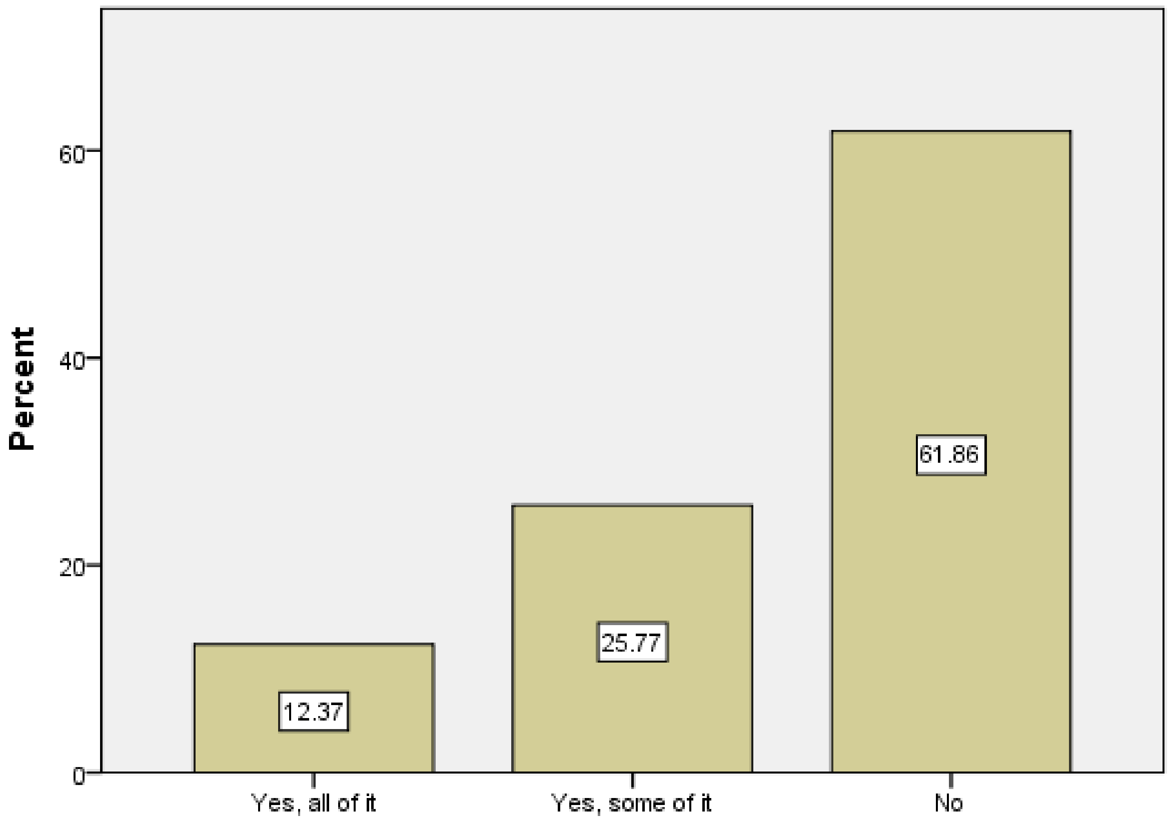

Figure 5 shows that that only 48(12.4%) of respondents said their household currently separates all non-biodegradable waste for recycling/reuse. Another 100(25.8%) indicated they separate some non-biodegradable waste and finally the majority of respondents, 240(61.9%) reported that their household does not currently separate any non-biodegradable waste for recycling or reuse.

Table 8: Barriers that make recycling /reuse difficult in Garowe, district Somalia.

Responses	Frequency	Percent
Lack of bins/pickup	107	27.6
Lack of space	136	35.1
Lack of knowledge	83	21.4
Takes too much time/effort	62	16.0
Total	**388**	**100.0**

The results of table 8 reveals that 136(35.1%) of respondents indicated that a lack of space makes recycling and reusing waste difficult for their household, Additionally, 107(27.6%) reported that a lack of bins and consistent pickup serves as a barrier then 83(21.4%) felt a lack of knowledge about recycling and reuse makes participation difficult and finally fewer respondents,62(16.0%) said the time and effort required makes recycling and reusing waste hard for them the study indicates the top barriers cited were lack of space, lack of bins/pickup, and lack of knowledge.

Figure 6 Satisfaction of the waste collection services in household of Garowe, district, Somalia

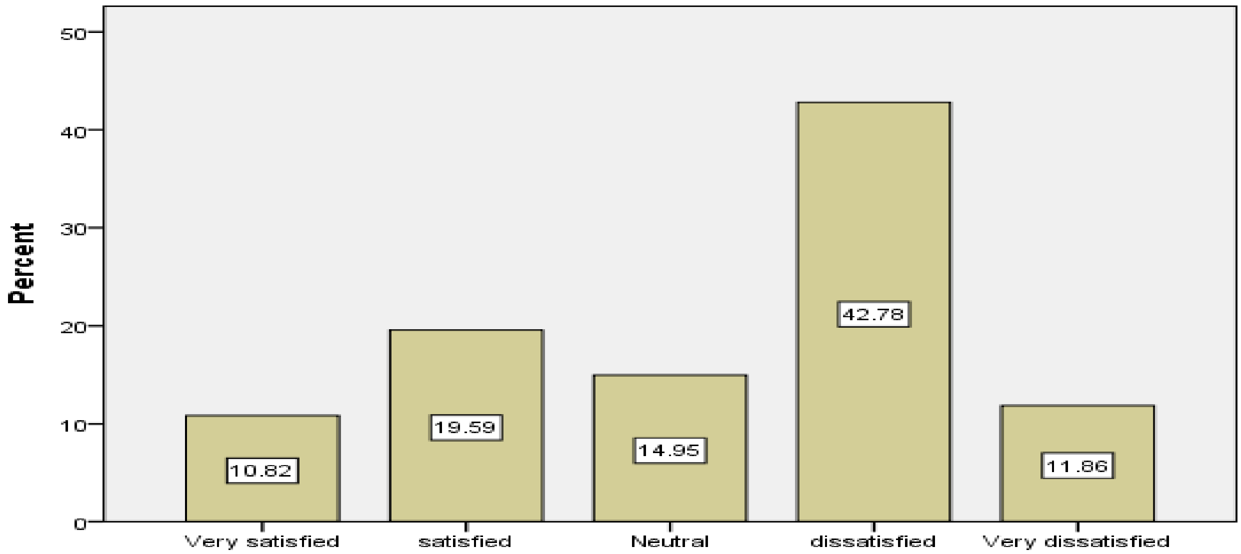

Figure 6 reveals that 166(42.8%) are dissatisfied, an additional 46(11.9%) are very dissatisfied. On the other hand, only 58 (10.8%) said they are very satisfied, and 76(19.6%) said they are satisfied.

Table 9 frequencies of waste collection in Garowe district.

Responses	Frequency	Percent
A few times per week	61	15.7
Once a week	113	29.1
Every other week	168	43.3
Less than once a month	46	11.8
Total	**388**	**100.0**

Table 9 shows that 61(15.7%) of households have waste collected a few times per week, 113(29.1%) have waste collected once a week, 168(43.3%) have waste collected every other week, and finally46 (11.8%). the results of the study indicate that the majority of households in Garowe district have their waste collected at least weekly.

Figure 7 Information on proper waste management practices

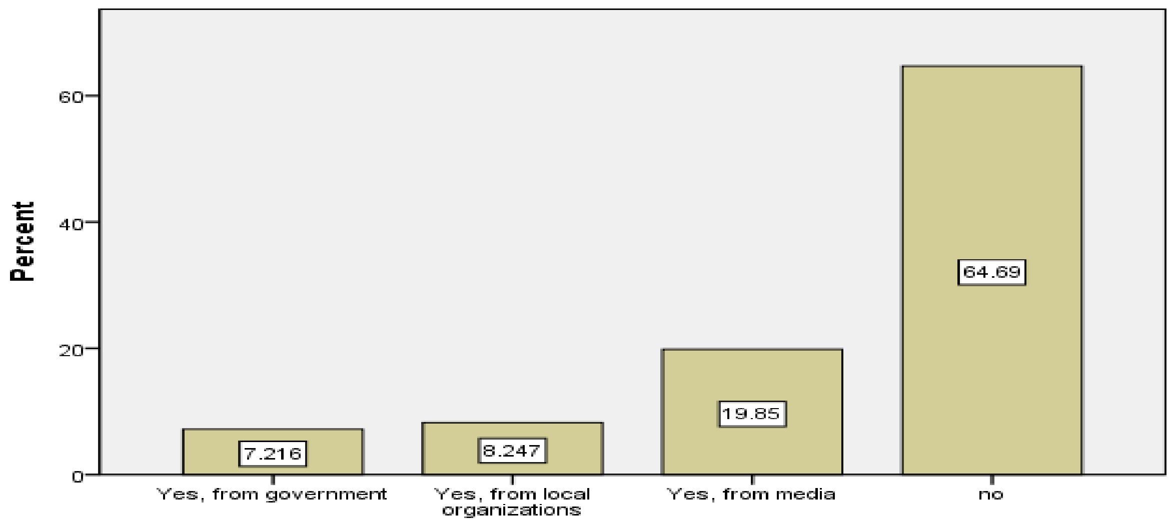

Figure 7 shows that143(36.9%) of respondents in Garowe district reported not receiving any information about proper waste management practices. 116(29.9%) said they received information from media, making this the most common source. 72(18.6%) received information from the government and 57(14.7%) received information from local organizations. The data shows room for improvement in educational outreach about waste management in Garowe district.

DISCUSSION

The research specifically examines the nature and volume of biodegradable trash produced in the Garowe District, with food scraps being the primary form of waste. The majority of respondents, more than 60%, indicate that food scraps are their primary source of biodegradable garbage. These food scraps make up more than 20% of the total municipal solid waste (MSW) generated worldwide [10]. The majority of homes in Garowe produce between 1 and 10 kilogrammes of biodegradable garbage each week, with variations in amounts influenced by variables like as geographical location, income level, and other related factors. The worldwide estimate for food waste alone is 2.01 billion tonnes, indicating that biodegradable materials make up a significant portion of municipal solid waste streams [21]. Composting is not widely practiced in Garowe homes, since just 34.5% of inhabitants engage in composting of biodegradable waste. Literature also indicates that there are high rates of waste disposal worldwide, which presents a substantial opportunity to enhance waste diversion by methods such as composting, anaerobic digestion, and other forms of recovery [22]. The survey participants identified a lack of understanding and available space as significant obstacles, highlighting the specific approaches required to promote the widespread use of composting. The research emphasises the significance of effectively handling non-biodegradable trash, particularly plastics, which are the most common kind of non-biodegradable garbage produced by homes in the Garowe District. Global forecasts indicate that more than 380 million tonnes of plastic garbage are created each year [23]. Even relatively small amounts of plastic debris per home may quickly accumulate on a large scale in cities and regions [24]. The district presently has minimal waste separation and recycling procedures, since fewer than half of the polled households reported sorting recyclables. The recycling rates in many developing nations are still around 10%, but in certain European countries, they have reached over 70%. [23]. This disparity underscores the need for progress. Electronic garbage, often known as e-waste, is the waste generated by discarded electronics. It is currently the waste stream that is expanding at the fastest rate worldwide. It is projected to reach a total of 75 million tonnes by the year 2030 [25]. Including e-waste collection and recycling, as well as diverting plastics, should be seriously considered when developing an integrated waste management strategy for the district. Non-reactive trash such as glass, textiles, rubber, and debris make up more than 50% of municipal solid waste (MSW) worldwide [5]. An method that focuses on the 3Rs - reducing, reusing, and recycling - together with the development of infrastructure and education, is the most effective way to achieve sustainable waste management in districts. The survey findings indicate a prevalent discontentment among residents in the Garowe District over the existing home garbage collection services. Only 30% of the participants expressed satisfaction, while more than 50% expressed unhappiness with the dependability, convenience, or quality of the service. More than 10% of respondents said that they did not get any information about appropriate trash management from the municipality or accountable authorities. This finding supports existing literature that highlights a lack of garbage education and outreach in several developing areas. Shifting from basic garbage collection and disposal to integrated sustainable management is in line with the 3Rs strategy, which emphasises waste reduction, reuse, and recycling [17]. The Garowe District produces a substantial quantity of biodegradable garbage, with food leftovers being the main constituent. The majority of families produce between 1 to 10 kilogrammes of biodegradable garbage on a weekly basis, but, the practice of composting is not widely adopted. District plastics are the most prevalent kind of non-biodegradable garbage, as reported by more than one-third of the respondents. The waste separation and recycling procedures are inadequate, since fewer than 50% of residents engage in the practice of sorting recyclable materials. This highlights the need for enhanced recycling infrastructure, services, and education in order to boost participation rates and redirect a greater amount of materials away from being thrown away [26]. The waste management procedures now used in the Garowe District essentially prioritise the collection and transportation of trash, with less attention given to waste segregation, recycling, or recovery. A significant majority of respondents, amounting to barely 30%, expressed satisfaction with residential garbage collection services, indicating a widespread discontent. There is a deficiency in public education on appropriate trash management, since more than one-third of people have reported not receiving any information from local authorities. In order to tackle these problems, the local municipal authorities should implement community education initiatives to promote home and neighbourhood composting. Additionally, they should establish centralised, large-scale composting facilities. Furthermore, they should offer training, protective equipment, and transportation assistance to integrate waste pickers into the process of separating and collecting organic materials for composting, both on a small and large scale. Establish systems for segregating and collecting recyclable materials such as plastics, metals, paper, and glass. This may be done by distributing bins, setting up drop-off points, and providing curb side pickup services. In order to assess the current waste management methods, the local government should carry out a comprehensive evaluation of the municipal services. This evaluation should aim to identify and resolve the causes that contribute to dissatisfaction with garbage collection. Additionally, the government should enhance communication efforts by implementing an educational campaign via media channels that are specifically customised to the local community. Additional examination of the survey results about biodegradable and non-biodegradable garbage is necessary to evaluate the level of community understanding of trash separation at its origin and fluctuations in waste makeup across different seasons.

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