Evaluation of storage and disposal of household waste in the city of Kinshasa (Communes of Lemba, Mont-Ngafula, and Kisenso) and awareness of eco-citizenship

ABSTRACT

This study aims to analyze and describe the characteristics of household waste in the communes of Lemba, Mont-Ngafula and Kisenso in Kinshasa, while raising awareness of ecological citizenship. The study was conducted from April 17 to May 3, 2023, with a sample of 690 households, 138 randomly selected from each community. The main methods used are survey, interview and observation in the field.

The results show that household waste management in the cities studied does not contribute to sustainable development. Most households use garbage cans, mainly buckets and bags, but waste sorting is rare, except in the Kindele area. The most common waste disposal methods are inappropriate local disposal and incineration. The most common methods of waste disposal are disposal in inappropriate locations and incineration. Average waste weights vary by neighbourhood, with values ranging from 8.67 kg to 13.99 kg per household. It has a significant correlation between the total weight of waste generated per household and household size.

The findings of the study indicate that the state of household waste management in these cities is worrying, with adverse consequences for the environment and public health. Proposals include new laws to regulate waste management, integration of waste management into urban development plans, establishment of landfills and public awareness of sanitation rules and the principles of waste reduction, reuse and recycling. Developing effective and sustainable strategies to address household waste management in these communities in Kinshasa is crucial. The involvement of local authorities, stakeholders and citizens is essential to protect the environment.

***Keywords**: household waste, garbage, management, recovery, method of disposal, eco-citizenship, municipality*

1. INTRODUCTION

According to Sané (1999), cited by Diabagate (2007), household waste includes waste produced daily by households. This concept includes broken glass, fallen leaves, sweeps, etc. On the other hand, waste refers to any product abandoned by its owner, such as old clothes, construction waste, etc.

The disposal of solid waste in households is an urgent problem that needs to be addressed. In cities lacking urban planning and health and environmental regulations, residents face inadequate living conditions, as Yapay (2001) notes.

Pierrat (2014) and Tchuikoua (2010) reported that the lack of appropriate garbage collection services in residential areas across Africa, particularly in Kinshasa, has created a serious problem. Due to the inefficiency of these services, waste has accumulated on roadsides, open spaces and between buildings and homes, causing significant health risks for local residents.

Kinshasa, the capital of the Democratic Republic of Congo, faces significant waste management challenges, generating about 5,600 tons of waste daily, mainly in the form of household waste (Lelo, 2008).

The issue of household waste management profoundly affects the city of Kinshasa, which is the capital of the Democratic Republic of Congo (Vuni et al, 2022).

The municipalities of Lemba, Mont-Ngafula and Kisenso are particularly affected by the problem of waste management, causing visual pollution and making the city unhealthy.

on the evaluation of the storage and disposal of household waste in the city of Kinshasa, with a focus on the communes of Lemba (Mbanza-lemba District), Mont-Ngafula (Neighborhoods: Kindele, Tshibanda and Masangambila) and Kisenso (Mbuku Neighborhood). An awareness campaign on eco-citizenship will be the continuation of this study, all with the aim of obtaining an in-depth understanding of the major problems related to household waste management in the city of Kinshasa.

The specific objectives accompanying this study are to:

- Identify current household waste management practices in the three municipalities.
- Quantify household waste in the Mbanza-Lemba, Mbuku, Tshibanda, Kindele and Masanga-Mbila neighbourhoods.
- Make recommendations for sustainable management of household waste.

2. MATERIALS AND METHODS

2.1 Materials

To conduct our investigations, we used different materials and tools, namely:

- A **smartphone** to deploy the questionnaire via the Kobocollect application from Kobotoolbox;
- **Two mechanical loads** (spring) to weigh the waste samples in their entirety, then separately for the different categories of waste (biodegradable and non-biodegradable) constituting each sample;
- **Plastic bucket** for sorting and weighing the raw contents of each sample, while taking precautions with the use of **polystyrene** surgical gloves and **masks** (nose mufflers) to avoid contamination during the process;
- A **GPS** (Global Positioning System) to geographically locate the study points;
- Software such as **QGIS**for mapping, **MS Word**for word processing, **R** for statistical analysis and **Excel** for creating tables.

2.2 Methods

2.2.1 Sample Selection Criteria and Survey Techniques

In our study, we selected a random sample of 690 households in the communes of Lemba (Quartier Mbanza-Lemba), Kisenso (Quartier Mbuku) and Mont-Ngafula (Quartiers: Tshibanda, Kindélé and Masanga-Mbila) in Kinshasa. A convenience sample was selected to conduct this survey. The choice of these municipalities was based on criteria such as their accessibility, the security they offer, as well as the availability in terms of time and financial resources.

The choice of households was made randomly within the sample of each municipality. The size of population samples for surveys and interviews was determined using the simple random sample principle, as described by Rea L.M. et al. in 1997.

$$n = \frac{t_p^2 \times \mathrm{P}(1-\mathrm{P}) \times \mathrm{N}}{t_p^2 \times P(1-P) + (N-1) \times y^2} \quad (1)$$

For data collection, we used techniques such as:

- Literature review;
- Free observation;
- Structured interviews.

2.2.2 Data processing.

The data were processed using Excel and R software, with chi-square independence tests between variables to highlight possible dependencies between them and the correlation test to assess whether there is a linear

relationship between the total weight of waste generated per household and household size. To achieve this, we set two conditions: Ho, H1 and r respectively the null hypothesis, the alternative hypothesis and the correlation coefficient.

- Ho: r = 0 (there is no linear relationship between the total weight of waste generated by households and the size of households).
- H1: r ≠ 0 (there is a linear relationship between the total weight of waste generated by households and the size of households).
  Hypothesis Ho was tested at the significance level of 5%.

Finally, the linear regression test was performed to determine the equation for the regression line.

Our study provides essential information on the current state of household waste management in selected municipalities, helping to guide policy and programme decisions to improve household waste management in the city. After collecting the data through direct observations and interviews, our team conducted an awareness campaign on eco-citizenship. The aim was to raise awareness of the threats to our planet, in order to become fully aware of the extent of the damage caused.

Specifically, our awareness focused on the use of closed bins, the location and hygiene of garbage cans, the sorting of household waste (biodegradable and non-biodegradable), waste treatment, recovery and strategies for sustainable management of household waste in urban areas.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Use of the bin for household waste storage

Based on our analyses, we found that in the neighbourhoods of Mbuku and Masanga-Mbila, all households (100%) use garbage cans. On the other hand, in the neighborhoods of Mbanza-Lemba (90%), Tshibanda (93%) and Kindele (84%), this rate has decreased slightly, as some people prefer to throw their waste in gutters and/or ravines rather than use a garbage can. The graph below illustrates the use of garbage cans in these respective neighbourhoods.

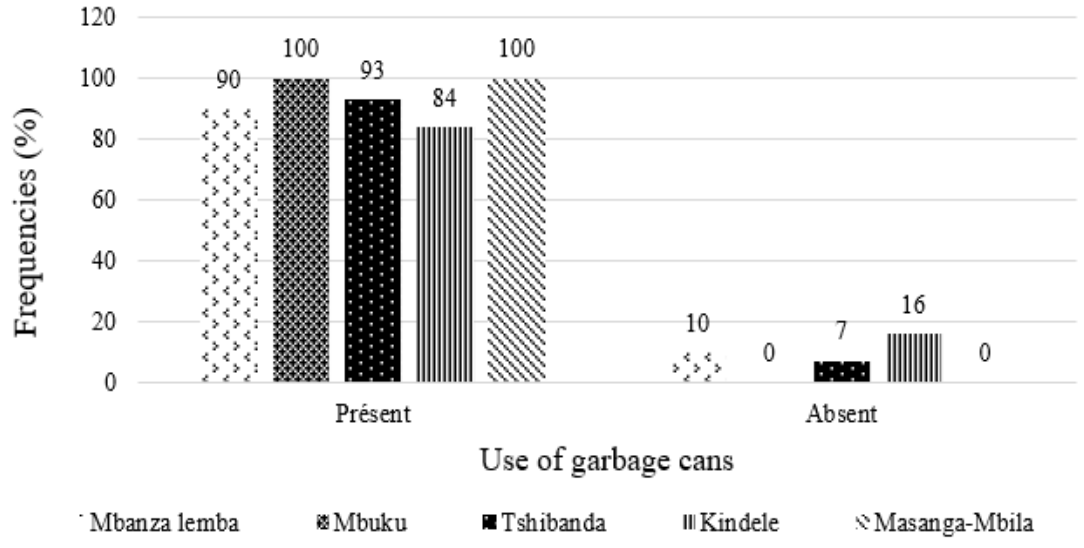

Fig. 1: Use of garbage cans in the Mbanza-lemba, Mbuku, Tshibanda, Kindele and Masangambila neighbourhoods

3.1.2 Types of garbage cans used per household

According to our data, seals and bags are the most commonly used types of garbage cans in the five neighbourhoods, mainly because of their durability and affordability. The figure (Fig. 2) shows the percentages of use of the different types of bins.

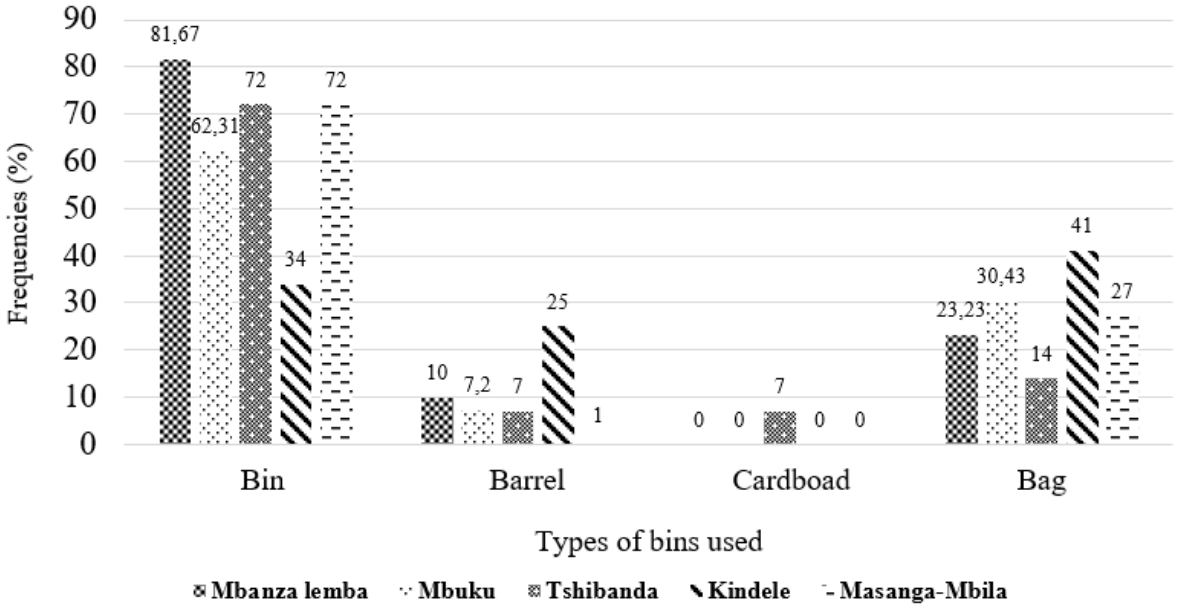

Fig. 2: Types of bins used per household in the five neighbourhoods

Based on our observations on the ground, we found that in the Kindele district, at least part of the population sorts waste, while in general, the majority of the inhabitants of the three municipalities do not sort. In addition, we noticed that almost all the bins are open.

3.1.3 Method of disposal:

The majority of neighbourhoods do not carry out any waste recovery. Rejection is the most common mode of elimination in the neighborhoods of Mbanza-Lemba (62%), Mbuku (47%), Kindelé (50%) and Masanga-Mbila (72%). The graph below shows the household waste disposal methods by district in the three municipalities.

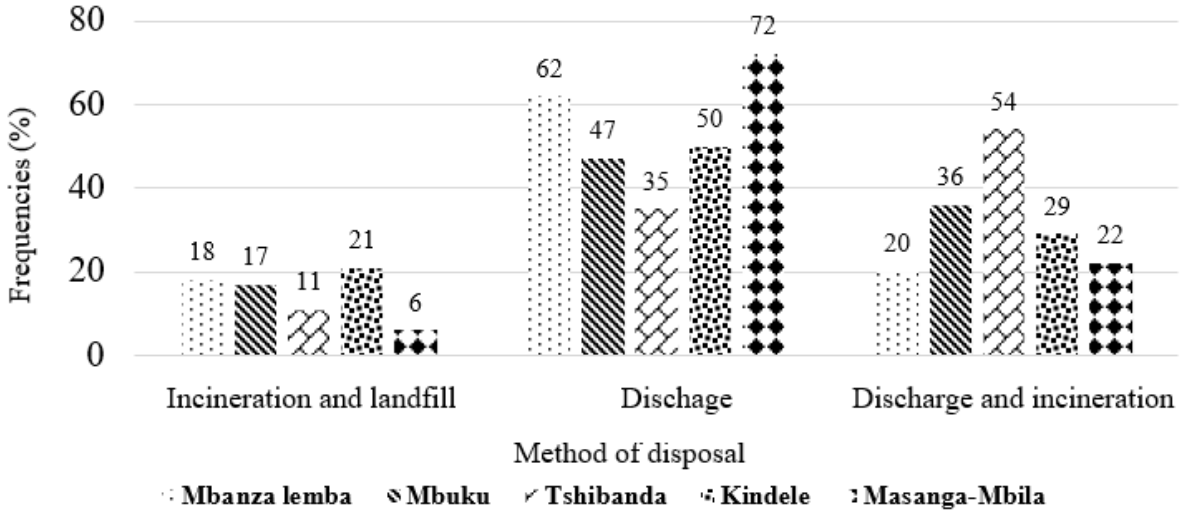

Fig. 3: Method of waste disposal in the five districts

In most neighbourhoods, the lack of a waste collection service results in waste disposal that does not meet environmental standards. Based on our interviews, we found that households subscribing to a collection service outnumbered those not, however, it is important to note that this subscription is mainly informal rather than formal.

3.1.4 Assessing the amount of household waste

Table 1:Categorization of household waste by neighbourhood

Quarters	Total weight (kg)	Average weight (kg)	Minimum weight (kg)	Maximum weight (kg)	Standard deviation	% organic	% inorganic
Mbanza-Lemba	1930	13,99	2	95	19,1	64,97	35,03
Mbuku	1368	9,91	3	92	17,90	66,81	33,19
Tshibanda	1714	13,93	4	52	7,77	80,57	19,43
Kindele	1196	8,67	2	37	5,92	70,82	29,18
Masanga-Mbila	1644	11,91	5	23	4,44	79,81	20,19

3.1.5 Relationship between waste weight and household size

Between the total weight of waste generated per household and household size, the results indicate a significant linear relationship($correlationcoefficientr = 0.8987537, p - value = 2.2e - 16 < 0{,}05$).
Thus, household size strongly influences the total weight of waste generated. Using the linear regression test, we get the regression line equation:

$$y = 2.0349x - 1.9898 \quad (2)$$

With y representing the weight of the waste and x representing the size of the household.

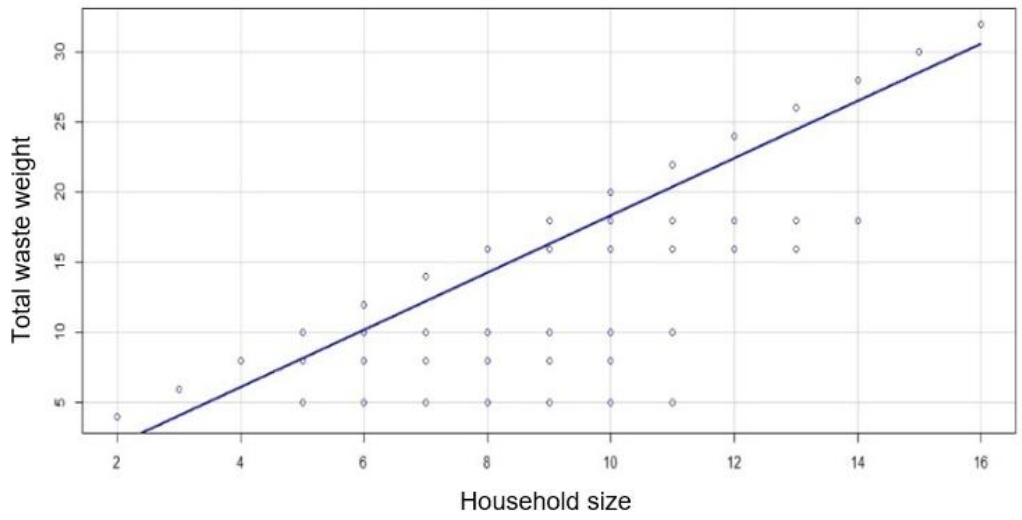

Fig. 4: Significant linear relationship between waste weight and household size

For waste by category (organic and inorganic), it is interesting to note that the weight of organic waste varies according to the size of the household:$(p - value = 1.3e - 16 < 0{,}05)$. Thus, the size of the household exerts a significant influence on the weight of organic waste produced per household. Applying the linear regression test, we get the following equation:

$$y = 1.403x + 0.49533 \quad (3)$$

With y is the weight of organic waste and x is the size of the household.

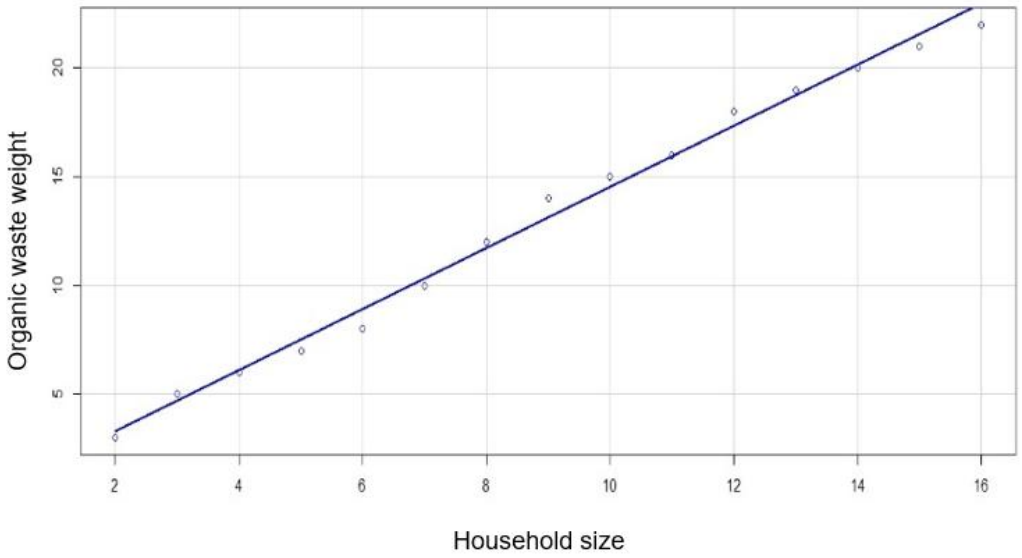

Fig. 5: Relationship between organic waste and household size

3.2 Discussions

The assessment and characterization of household waste in the city of Kinshasa (communes of Lemba, Mont-Ngafula and Kisenso) yielded significant results.

Our surveys reveal that there is a small disproportion between households that sort their household waste and those that do not. According to Kakudji et al. (2019), this situation can be explained by the lack of household awareness of household waste management and the importance of waste sorting. The difference in subscription rates for waste collection services between different municipalities may be due to several factors, such as the

availability and accessibility of waste collection services, the level of household awareness and participation, and the cost of services.

The lack of a collection service is one of the most common reasons why people do not subscribe to household waste collection services. The study by Fanny et al. (2013) shows that the different waste streams are indeed collected as a voluntary contribution, a collection method that is generally used only by users most motivated by recycling because of the considerable efforts it requires.In the study by Guylain N et al., it is stressed that the absence of a good waste management policy creates serious problems that affect both the health of this population and the space it occupies, as well as the environment as a whole. Hence, this exposes to an increased risk of diseases, the presence of multiple erosions, pollution and environmental degradation.

The negative impact of waste on the environment can be reduced by introducing waste recycling practices such as controlled incineration or composting. The study by Holenu et al. (2020) shows that these practices recover valuable resources from waste while reducing greenhouse gas emissions and water and soil pollution.

The majority of households do not recover their household waste but others that recover part of it. This is because some households used kitchen debris as a source of feed for poultry, fish and pigs and also as organic matter. Mukuku et al. (2018) in his work state that 96.1% of households do not recover waste. This is usually due to lack of information.

Around collection points in the town of Mekelle, households continued to throw their waste in open spaces and streets, even with bins present, as found in research by Tadesse et al. in 2008. In recent findings by Hollenu et al., more than three-quarters of participants admitted to dumping their waste in unauthorized places, and only a fraction (26.4%) used collection points. Moreover, Kanyenye B.A. insight offered. In the study, the results showed that behind the market was a forbidden dump where the majority of traders (73.80%) carelessly threw their waste and this area belonged to the Salvation Army. On the other hand, a small percentage (16.17%) opted for the LALU erosion landfill, close to the market and managed by Kimbanguists. An insignificant proportion of participants (10.03%) had no knowledge of their waste disposal method. This leads to air pollution that alters the environment beyond recognition.

Throughout our study, rejection is the most common mode of elimination. These results are contrary to those of Warunasinghe et al. (2016) among which incineration (44%), composting (16%) and incineration (10%) are modes of household waste disposal. Hollenu et al. (2020) state that the most common disposal methods are incineration and landfilling. This discrepancy may be due to the lack of waste recycling and the presence of many ravines suitable for illegal dumping.

4. CONCLUSION AND RECOMMENDATIONS

This study opens the minds of researchers to the question of integrated waste management and the dangers arising from the three municipalities mentioned above. Its main objective was to analyze and characterize household waste in the communes of Lemba, Kisenso and Mont-Ngafula in Kinshasa, with the aim of promoting eco-citizenship.

The results clearly demonstrated that the management of household waste in these municipalities does not contribute to sustainable development, because waste does not follow a sustainable management path. This worrying sanitation situation has adverse consequences for the environment and public health. Based on these results, we hope that this study will encourage the implementation of concrete actions to improve waste management and promote environmentally friendly practices within these communities.

In order to finally solve these problems of household waste management, adequate strategies must be put in place, involving urban and municipal authorities and the population for a concrete commitment to the preservation of the environment.

There is a need to find effective and sustainable solutions to address household waste management problems in Kinshasa's Lemba, Kisenso and Mont-Ngafula communes. Here are our recommendations:

- To legislative authorities: Develop new legislation and laws to regulate waste management, especially household waste, at the national level;
- To urban and municipal authorities and all stakeholders involved in waste management:
    - Integrate waste management into urban development plans;

- Establish public landfills in municipalities: create a large number of transit sites accessible to residents and collection trucks, in order to facilitate the collection of household waste in all neighborhoods and optimize transport to the technical waste treatment centers provided for this purpose. The determination of the number of transit sites and the choice of their location should be carried out by neighbourhood;
- Revitalize the hygiene department to monitor and control household waste management.
- Raise awareness and educate the population on hygiene rules;
- Set up a household waste disposal tax or apply the "polluter pays" principle in Kinshasa, taking into account the standard of living of the population;
- Given the urgency of the health and environmental effects of waste, there is a need to effectively manage solid household waste by applying waste management principles, including the 3Rs (Reduce, Reuse and Recycle).

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