

# Sustainable Waste Management across Cameroon Cities: Households Perspective in Nkongsamba, Littoral Region

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## Abstract

This study examines sustainable waste management practices from the household perspective in Nkongsamba, Cameroon, highlighting challenges and opportunities within urban settings. The research is guided by three primary objectives: 1) to assess the current waste management practices among households; 2) to identify the barriers to effective waste disposal and recycling; and 3) to explore community perceptions regarding municipal waste management services. Employing a mixed-methods approach, data were collected through semi-structured questionnaires administered to 155 households and complemented by field observations. Qualitative insights were gathered from interviews with municipal leaders, quarter heads, and waste recycling agents. This dual approach allowed for a comprehensive understanding of waste management behaviors and stakeholder perspectives. The findings reveal that while many households engage in basic waste separation, significant barriers persist, including inadequate municipal services, lack of awareness about recycling benefits, and insufficient infrastructure. Additionally, community perceptions indicate a general distrust in municipal waste management effectiveness, leading to alternative disposal methods. Based on these findings, the study recommends enhancing public awareness campaigns about proper waste management practices and the benefits of recycling. Furthermore, investment in waste management infrastructure and improved service delivery from local authorities is crucial. Engaging communities in the development of waste management policies will also foster trust and cooperation, ultimately contributing to more sustainable waste management practices across Nkongsamba and other cities in Cameroon.

## Keywords

Sustainable Waste Management, Households Perspective, Nkongsamba, Cameroon

## 1. Introduction

The concept of waste is inherently subjective; what one individual perceives as waste may be viewed as a valuable resource by another (Amasuomo & Baird, 2016). This perspective can be advantageous in the waste management process, as not all discarded materials should be classified as waste. Certain components can be deemed significant and serve as feedstock for various applications. Conversely, waste can also be monetized or, at the very least, reduce the high costs associated with treatment through an integrated waste management system (IWM). Global report indicates that an estimated 9 billion tonnes of waste are generated worldwide (Wilson & Velis, 2015). With Municipal Solid Waste (MSW) being a distinct category derived primarily from households, the commercial and industrial waste production has doubled. In 2016 alone, MSW constituted 2 billion tonnes of the total waste produced worldwide. Lower-middle income countries account for about a third of the waste generated globally, with sub-Saharan African countries in particular projected to triple the amount of generated waste by 2050 (Kaza et al., 2018). This category warrants particular attention due to its significant environmental implications at local, regional, and global levels, the close proximity of waste to human populations and the associated health risks, as well as its potential for recovery within circular economy frameworks (European Commission, 2015). Given the growing rate of urbanization in developing countries, solid waste possesses serious environmental issues. To solve this problem, diverse institutions have set in to manage municipal solid waste.

The sustainable management of solid waste is crucial for mitigating environmental impacts and safeguarding public health globally (ISWA, 2002; Fletcher & Read, 2003; Ball, 2006). While developed countries have a well-established understanding of the components necessary for effective waste management systems such as those outlined by Read (1999) from a UK perspective, this knowledge is often lacking in developing nations as most countries face challenges in managing their waste (Linda Godfrey, 2021). The pressure is acute in low and lower-middle income countries, where growing amounts of waste caused by increased population (Wilson & Velis, 2015), urbanization trends and economic development (Modak et al., 2016) have produced alarming negative impacts, primarily on human health and the environment (Ferronato & Torretta, 2019; Hyman, 2013). The increasing generation of waste has led to a shortage of disposal sites and elevated waste management costs. In Accra, Ghana, for instance, expenditures for municipal solid waste (MSW) rose by 8% from 2013 to 2015 (Oduro-Appiah et al., 2017).

Other developing countries face several critical challenges in waste management, including inadequate governance frameworks, inefficient resource utilization, reliance on imported technologies, sub-optimal financing mechanisms, disparities in service provision, and a lack of technical expertise (Ghazvinei et al., 2017). Here, governance-related issues often overshadow technical considerations, highlighting

the need for comprehensive policy reforms to enhance waste management practices (Rodić & Wilson, 2017). In South Africa, a waste management hierarchy has been integrated into national waste legislation to promote sustainable development (DEA, 2012). Despite this framework, approximately 90% of waste generated in 2011 was still directed to landfills. The diversion of recyclable materials from landfills is a global challenge that plays a crucial role in advancing a circular economy. This economic model aims to maximize resource longevity through strategies such as reuse, recycling, and recovery (Da Silva, 2018; Rada & Cioca, 2017). Effective waste diversion strategies are strongly needed in South Africa to mitigate landfill dependence and also to enhance resource efficiency, reduce environmental impacts, and foster economic resilience.

The existing literature on various facets of waste management in Cameroon including collection, transportation, treatment, reuse, recycling, recovery, and disposal is limited (Vermande & Ngnikam, 1994, Ngnikam, 2000). This scarcity of data hampers the ability to assess the current waste management situation and to draw meaningful comparisons with practices in other countries. Given that the country's population is rapidly increasing with more than half already concentrating in cities, protecting public health and the environment becomes a crucial issue. The discharge of wastes reflects on people's life style and social activities. Garbage is generated from the population daily activities and therefore, waste may result from industrial structure, physical distribution and people's consciousness about garbage. Increasing population also means increasing garbage which is technically called as 'solid waste' or only as "waste". Cameroon, like other countries, she is facing high rate of urbanization, estimated at about 4% annually, compared to an annual population growth of about 2.7% (Manga, Osric, & Adam, 2007). Uncollected and illegal disposal of waste poses serious risk to public health and the environment. In the littoral region of Cameroon in general and in Nkongsamba subdivision in particular, waste generation increases everyday as the result of rural urban interaction and development and high birth rate among youthful population.

## 2. Conceptual Frame

### The Concept of Waste

Most human activities generate waste (Brunner & Rechberger, 2014). Despite that, the production of wastes remains a major source of concern as it has always been since pre historic period (Chandler et al, 1997). In recent times, the rate and quantity of waste generation have been on the increase. As the volume of wastes increases, so also does the variety of the waste increases (Vergara & Tchobanoglous, 2012). Unlike the pre historic period where wastes were merely a source of nuisance that needed to be disposed of. Proper management was not a major issue as the population was small and a vast amount of land was available to the population at that time. In those days, the environment easily absorbed the volume of waste produced without any form of degradation (Tchobanoglous et al, 1993).

A substantial increase in volume of wastes generation began in the sixteenth century when people began to move from rural areas to cities as a result of industrial revolution (Wilson, 2007). This migration of people to cities led to population explosion that in turn led to a surge in the volume and variety in composition of wastes generated in cities. It was then that materials such as metals and glass began to appear in large quantities in municipal waste stream (Williams, 2005). The large population of people in cities and communities gave rise to indiscriminate littering and open dumps. These dumps in turn formed breeding grounds for rats and other vermin, posing significant risks to public health. The unhealthy waste management practices resulted in several outbreaks of epidemics with high death tolls, consequently, in the nineteenth century public officials began to dispose waste in a controlled manner in order to safeguard public health (Tchobanoglous et al, 1993).

In the context of this study, sustainable waste management encompasses the integration of environmental, economic, and social dimensions in waste disposal practices. In Nkongsamba, household perspectives serve as a critical lens through which to understand these dimensions. This framework identifies key components: Waste generation, which examines household behaviors and types of waste produced; waste disposal Methods, focusing on practices such as segregation and recycling; and community engagement, highlighting the role of local awareness and participation. Additionally, barriers to effective management, including infrastructural challenges and perceptions of municipal services, are explored to inform strategies for enhancing sustainability in urban waste management across Cameroon.

Figure 1 illustrates an integrated waste management system. The understanding spectrum of waste streams to be managed and presents available waste management

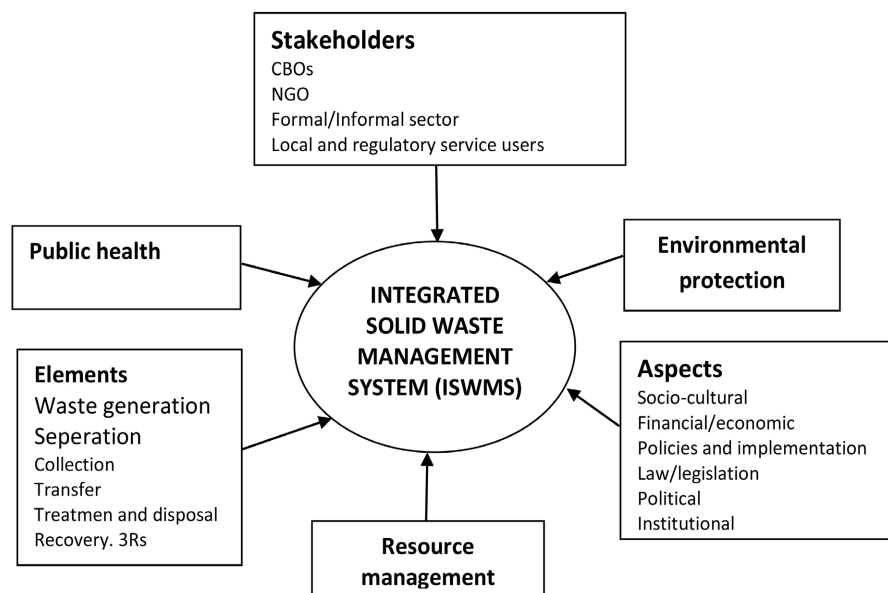
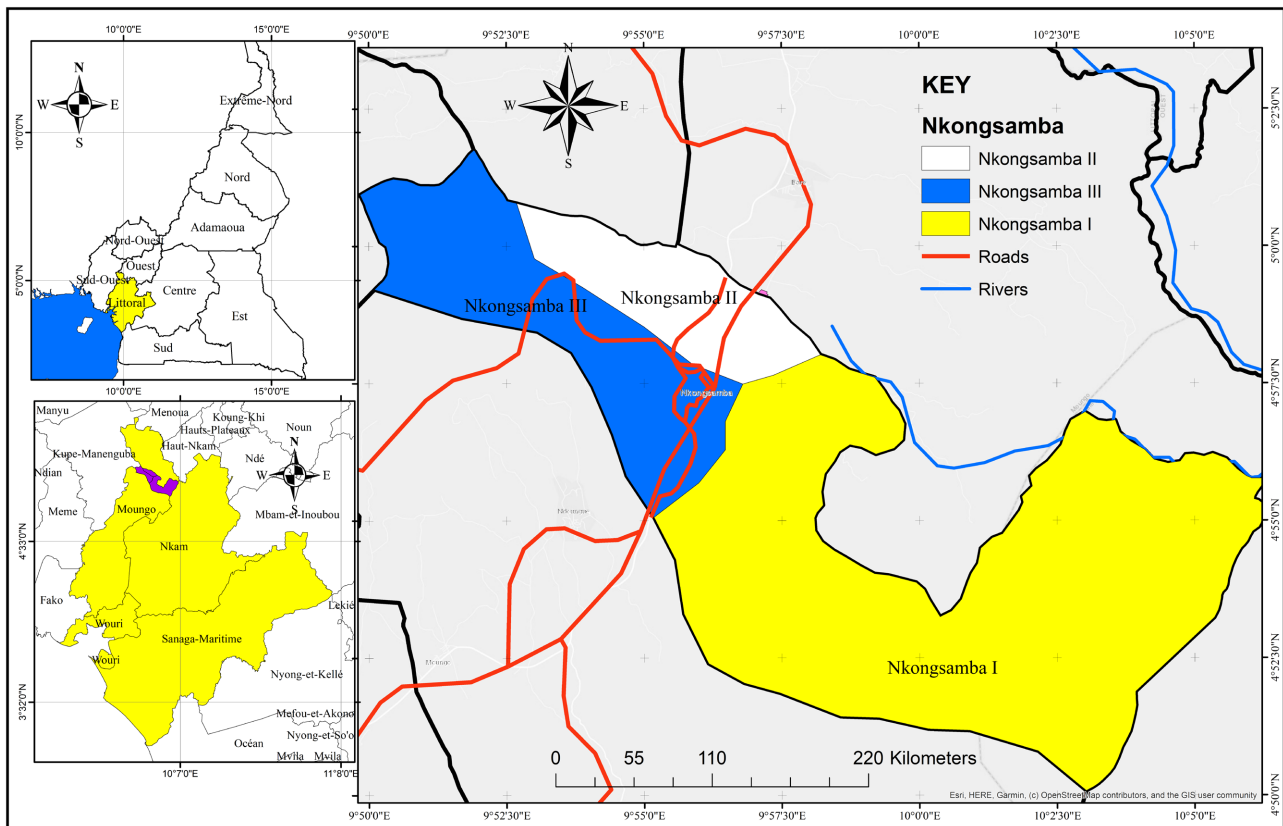


Figure 1. Concept of integrated solid waste management system.

practices as a diverse menu of options. Stakeholders can then choose the most suitable option based on specific environmental, economic, and social factors relevant to their location.

### 3. Materials and Method

This study was conducted in Nkongsamba, a town located in the Moungo Division of the Littoral Region of Cameroon as shown in **Figure 2**. Geographically, it is positioned between 4°5'4" and 5°10'00" North latitude and 9°30' and 10°00' East longitude. Nkongsamba is situated at the base of Mount Manengouba, with an elevation of 828 meters above sea level. According to projections by the Nkongsamba City Council in 2019, the town's population is estimated to be 117,063, making it the fourth largest town in the Littoral Region. Nkongsamba lies along the Douala-Bafoussam highway (N5) and is bordered to the north by Bare Bakem and Melong, to the south by Ebone, Manjo, Loum, and Njombe-Penja, to the east by Nanako Subdivision, and to the west by Bangem in the Kupe-Muanenguba Division. The city is administered by three councils: Nkongsamba I, Nkongsamba II, and Nkongsamba III, under the governance of a city council led by a government delegate. The town's population is estimated to exceed 130,000 inhabitants, based on projections from the Nkongsamba City Council for 2012.



Source: Authors, realization from Google earth, 2024.

**Figure 2.** Location of Nkongsamba in the littoral region.

This study employed both quantitative and qualitative research approaches to gather data on sustainable waste management, focusing specifically on the perspectives of households in Nkongsamba, Cameroon. To quantitatively assess household waste management practices, we distributed semi-structured questionnaires to a sample of 155 households across Nkongsamba. The questionnaire was designed to capture various aspects of waste management, including types of waste generated, disposal methods, and recycling practices. Field observations were also conducted to gain insights into the actual practices of solid waste management within the community. The sampling strategy involved stratified random sampling to ensure representation from different socioeconomic backgrounds and geographical areas within Nkongsamba. The collected data were analyzed using statistical methods to identify trends and patterns in waste management behaviors. For an in-depth analysis of the quantitative findings, we employed qualitative methods that included semi-structured interviews with key stakeholders. These stakeholders included the mayors of the three municipalities, neighborhood leaders (quarter heads), and waste recycling agents. The interviews aimed to explore their insights on the challenges and successes of waste management in Nkongsamba.

Participants who expressed a willingness to contribute were immediately selected for interviews. To encourage candid responses, research participants were assured that their confidentiality would be maintained and that their input was solely for research purposes. This assurance helped establish trust, allowing participants to share their honest opinions and experiences regarding waste management practices.

## 4. Results and Analysis

The analysis identifies three primary themes: the management of waste from its generation and segregation to collection and treatment, the shortcoming to effective waste disposal and recycling; and the community perceptions regarding municipal waste management practices. These themes reveal the reciprocal and often unfulfilled expectations regarding appropriate behaviors and responsibilities between two key groups: waste producers (households) and managers on one side, and government authorities on the other. This dynamic sheds light on the differing priorities and structures that influence their interactions.

### 4.1. Waste Management Practices (WMP) among Households in Nkongsamba

The WMP in Nkongsamba starts from generation (who generate the waste) collection to disposal (who collects and disposed the waste). Though this process faces significant challenges because of the amount of waste collected which only accounts for a small portion of the total waste generated. Reliable statistics on generation and collection efficiency are also lacking. There is typically no differentiation between service providers for households, industrial and hospital waste channels, given that the government provides clear legal framework on this.

Consequently, these waste channels are often mixed prior to disposal. Although the City Council in partnership with Red Plast Sarl NGO is charged with the responsibility for the entire waste collection and treatment process, this responsibility is frequently delegated to private third-party companies.

#### 4.1.1. Who Generate Waste in Nkongsamba

**Table 1** identifies waste production agents in Nkongsamba, the segregation, the waste types and their frequencies. From the descriptive results, principal agents in waste production are households, market traders, hospitals and industries. From their production types, 81.3% food scraps are the most commonly waste type produced by households, others like plastic containers are frequently produced at 50.3%. The rest of household's waste production types fall below 33.5% including paper waste, broken glasses and card boards. Another significant agent of waste generation are market traders in Nkongsamba. Field findings show that these agents produce 60.0% of plastic waste, 70.3% of nylon waste, 75.4% of paper waste, 77.4% of organic waste and 55.5% of unused fabric remnants. Hospitals in the study area also dumped waste and it is observed that 14.1% of chemical waste littered at open spaces given that this kind of waste is to be properly managed, 9.6% sharps waste is produced by hospitals, 11.5% of pharmaceutical waste were reported in the study, biological waste constituted 5.8% as the least medical waste generated. The most predominant of the hospital waste produce is medical devices such as used syringes, bandages, and trip tubes which 25.8% are disposed on the environment of Nkongsamba. The last noticeable agents of solid waste producers are attributed to industries implanted in the city. They produce 48.0% construction and demolition debris, 21.3% of food processing waste, 38.1% electronic waste, 29.6% metal shavings and 21.9% motor garage waste.

As shown on **Figure 3**, households emerge as the primary waste contributors 61.9%, with food scraps and plastic containers dominating their waste profile. Market traders significantly amplify the plastic and organic waste footprint 43.8%, this highlights the need for effective segregation and management strategies, while industrial activities at 26.4% introduce significant volumes of construction debris and electronic waste, necessitating the need for targeted interventions. Lastly, hospitals 10.3%, though a smaller waste producer, present unique challenges with hazardous waste, emphasizing the importance of proper disposal protocols.

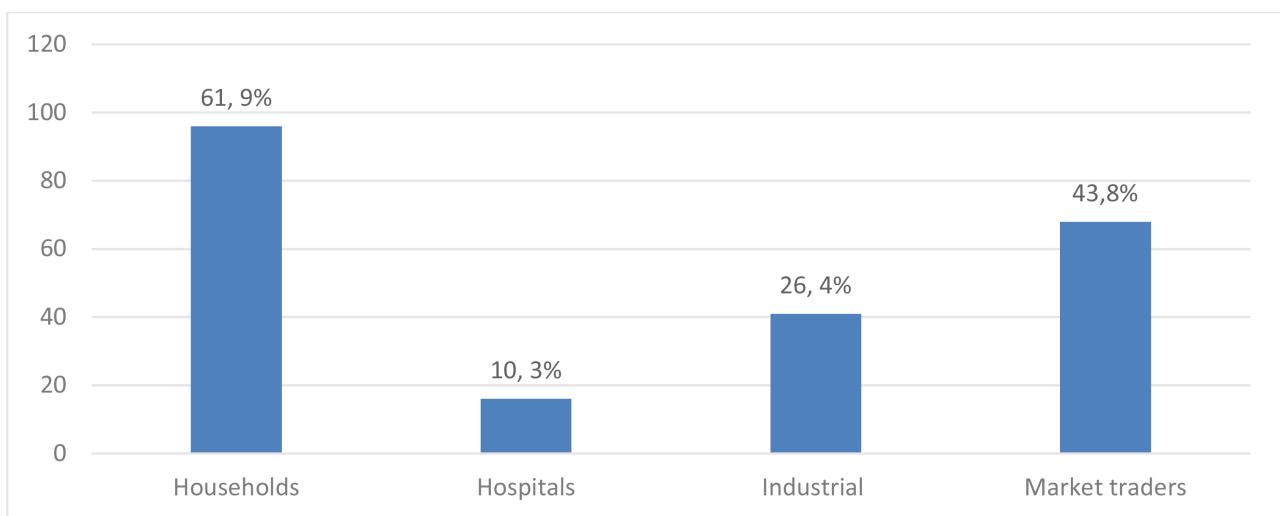
#### 4.1.2. Who Collects and Disposed the Waste in Nkongsamba

At the moment, five primary actors are involved in the collection and disposal of waste in the city of Nkongsamba: the Urban Councils of Nkongsamba; Red-Plast Sarl, a company that has specialized in waste collection and recycling for the past ten years in the city; market employees who sweep the markets and disposed the waste at bins; households who collect waste from their houses to designated communal dustbins; and industrial especially boulangerie and bakeries factories. So far, two primary methods are employed for municipal waste collection in

**Table 1.** Agent of waste production and types in Nkongsamba.

<i>Who generate the waste</i>	<i>Waste production types</i>	<i>Frequency</i>	<i>%</i>
<i>Households</i>	Food scrap	126	81.3
	Paper waste	52	33.5
	Broken glasses items	23	14.8
	Card board	16	10.3
	Plastic containers	78	50.3
<i>Market traders</i>	Plastic waste	93	60.0
	Nylon papers	109	70.3
	Paper waste	115	75.4
	Organic waste	120	77.4
	Unused fabric remnants	86	55.5
<i>Hospital</i>	Chemical waste	22	14.1
	Sharps waste	15	9.6
	Pharmaceutical waste	18	11.5
	Biological waste	9	5.8
	Medical devices	40	25.8
	Medical laboratory waste	11	7.1
<i>Industries or factories</i>	Construction and demolition debris	76	48.0
	Food processing waste	33	21.3
	Electronic waste	59	38.1
	Metal shavings	46	29.6
	Unwanted vehicle scrap	34	21.9

Source: Fieldwork, 2014.



Source: Fieldwork, 2024.

**Figure 3.** Ranking of waste producers in Nkongsamba.

Nkongsamba: door-to-door collection using trucks and fixed communal bins. Door-to-door collection is the predominant method, wherein waste collectors through HYSACAM employ a distinctive car alarm sound to alert residents of their arrival. This sound acts as a signal for residents to gather and place their sorted waste into sacks for collection, occurring either weekly or biweekly at designated road junctions.

**Table 2** shows the actors involved in the waste management in Nkongsamba, it also indicates the methods of waste collection, the types of waste collected, as well as the disposal method.

**Table 2.** Actors, methods and types of waste collection in Nkongsamba.

<i>Actors</i>	<i>Method of collection</i>	<i>Types of waste</i>	<i>Disposal method</i>
<i>Residents</i>	They gather waste from home	Food waste, paper, cardboard, plastic, textiles, leather, yard waste, wood, glass, metal, ash, special waste (e.g., bulky items, consumer electronics, batteries, oil, tires) and household hazardous waste	Burning, dump in streams, road side, designated dustbins
<i>Red-Plast Sarl</i>	They collect, sort and treat household waste especially non-organic waste	Housekeeping waste, packaging, construction and demolition materials, hazardous waste, ash, bottles, and plastic papers	Landfill, recycling
<i>Urban Council of N</i>	Door-to-door collection, quarter drop-off point, schedule collection days by HYSACAM, collaboration with NGO (Red-plast Sarl), street bins	Street sweepings; landscape and tree trimmings; general waste from parks, removal of garbage form road gutters,	Open burning, landfill, recycling
<i>Market cleaners</i>	They sweep the market, designate waste stations, sort bins, do regular patrol to collect litter and waste	Paper, cardboard, plastic, wood, food waste, glass, metal, special waste, hazardous waste	Open burning, Designated dustbins, streams
<i>Industrial</i>	Segregate waste at the source, provide waste bins, collaborate with municipal waste collection services regular pickups	Industrial process waste, scrap materials, off-specification products, slag, tailings	Open burning, Designated dustbins, landfill, recycling

Source: Fieldwork, 2024.

#### 4.1.3. Waste Management Practices in Nkongsamba

While it is very common for developed countries to take seriously waste reduction, recycle, recover, and reuse as a technique for waste management practice, developing countries like Cameroon has substitute for this.

**Table 3** provides a quantitative analysis of waste management practices in Nkongsamba, revealing both the frequency and percentage of various management practices employed by the community. The data indicates that landfill is a predominant practice of waste disposal at 72.3%. This reliance on landfilling suggests a traditional waste management approach that, while straightforward, raises concerns regarding potential environmental impacts such as soil and groundwater contamination. Another practice noted is the burning of waste at a significant rate

of 61.3%. This practice is mostly done at the level of households, market environments and dump sites near water courses and roadsides. While the practice is prevalent, it poses serious health hazards due to the release of harmful pollutants into the air.

Modern methods were also identified alongside the traditional practices. This includes recycling efforts, such as recycling aluminum pot fabric 55.4%, show a moderate level of engagement. This practice demonstrates a positive step toward resource recovery. The table also highlights innovative reuse practices, such as utilizing waste tires for stream embankment 40.0% and using plastic bottles for plant nurseries 34.8%. These practices by Red-plast Sarl suggest a growing awareness of the benefits of repurposing waste. Additionally, the transformation of organic waste into manure, reported at 49.6%, stands out as the most environmentally sustainable practice in the dataset. This method not only diverts waste from landfills but also enriches soil, promoting sustainable agricultural practices within the Nkongsamba community. On the lower end of the spectrum, practices such as decomposing waste for biogas production gave 5.8% observation and utilizing textile waste for decorations at 9.6% indicate underutilized opportunities for enhancing waste management strategies. The limited adoption of biogas production points to a potential area for growth, given its benefits in renewable energy generation.

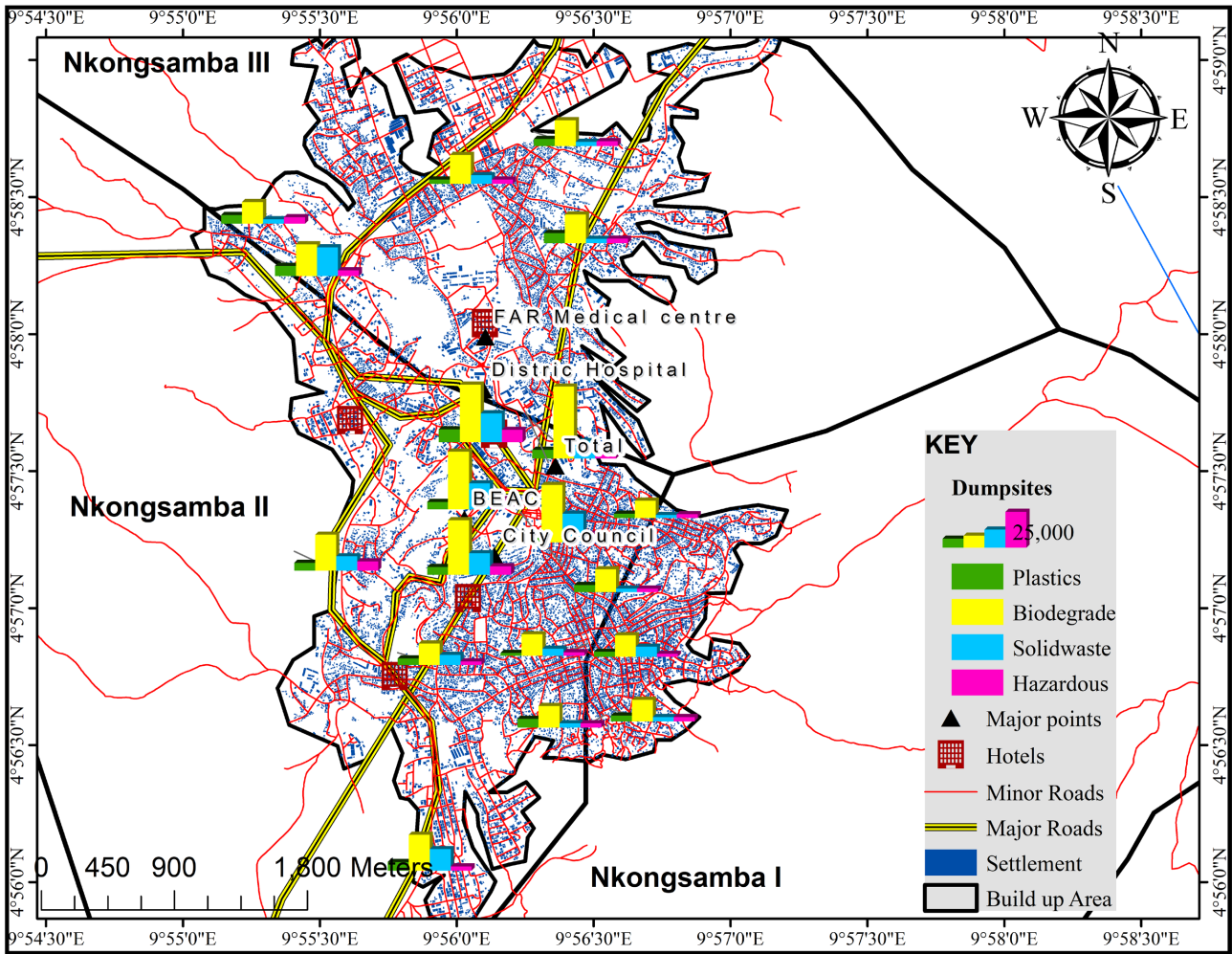
**Table 3.** Waste management practices in Nkongsamba.

<i>Management Practices</i>	<i>Frequency</i>	<i>%</i>
<i>Landfill</i>	92	59.3
<i>Burning of waste</i>	85	54.8
<i>Recycle for aluminum pot fabric</i>	86	55.4
<i>Use waste tires for stream embankment</i>	62	40.0
<i>Use plastic bottles for plants nursery at yards</i>	54	34.8
<i>Transform organic waste into manure</i>	77	49.6
<i>Textile waste for billows and other decorations</i>	25	16.1
<i>Decomposed waste for biogas production</i>	9	5.8
<i>Recycle waste into pavement blocks</i>	15	9.6

Source: Fieldwork, 20124.

While Nkongsamba exhibits a range of waste management practices, there is clear potential for improvement in recycling and sustainable methods. Targeted initiatives and community education could foster a shift towards more eco-friendly approaches, aligning with global waste management standards.

**Figure 4** shows spatial distribution map of waste management practicing sites in Nkongsamba. From the map, highest concentration of waste management site is toward the city center and diminishing towards the peri-urban areas.



Source. Fieldwork, 2024.

Figure 4. Distribution of waste management sites in Nkongsamba.

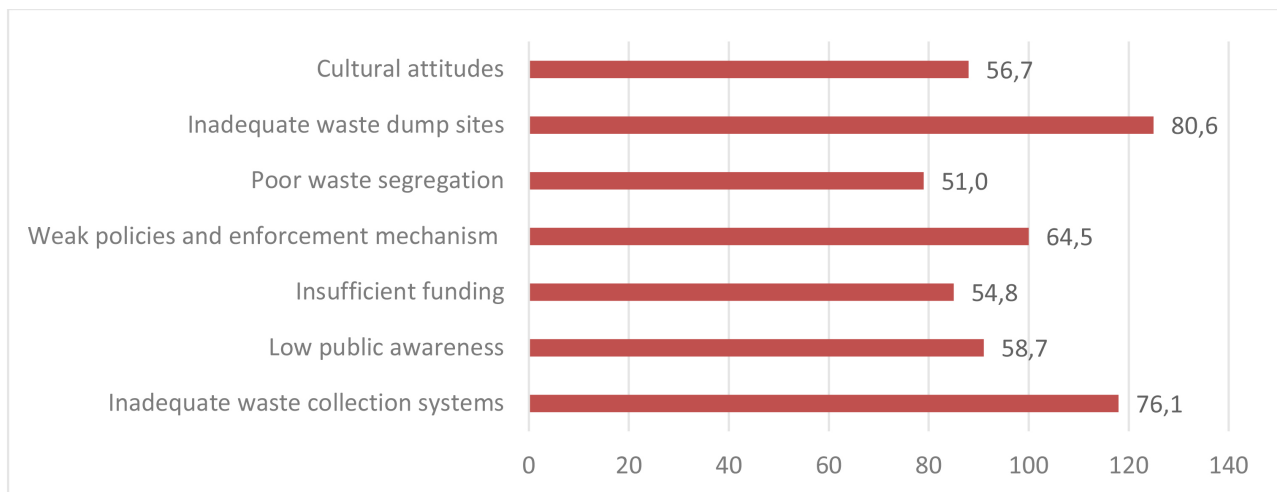
### 4.2. Challenges to Effective Waste Disposal and Recycling in Nkongsamba

Rapid urban growth, characterized by increasing population density, traffic congestion, and heightened air and water pollution, has led to a surge in per capita solid waste generation in Cameroon cities. This situation is compounded by a scarcity of suitable land for waste disposal, exacerbating the already critical challenges of solid waste management. As Cameroon cities expands in terms of residential, commercial, and industrial sectors, the demand for effective waste management solutions is expected to rise. But this has not been the case, hence the growing proliferation of solid waste littered everywhere around the cities. In the absence of regular solid waste collection systems, discarded materials often accumulate in open spaces, along access roads, near watercourses and streams. These informal dumpsites attract waste pickers and scavenging animals, which further disrupt the waste and create unsanitary conditions. This accumulation of waste becomes a breeding ground for disease vectors, including flies and rats, increasing public health risks. City authorities in

Cameroon faces numerous setbacks in managing this sector stemming from unplanned urbanization and administrative bottlenecks.

Moreover, leachate from decomposing waste infiltrates the soil and contaminates nearby water sources, posing serious environmental threats. The resultant pollution affects food, water, and soil quality, leading to potentially harmful consequences for ecosystems and human health. Additionally, uncollected waste frequently enters open drainage systems, causing blockages that result in stagnant water, creating ideal conditions for mosquito breeding, contributing to the spread of air and water borne diseases.

The results presented in **Figure 5** illustrate the barriers to effective waste management in Nkongsamba. Field findings highlight a myriad of challenges confronting stakeholders involved in waste management practices. Notably, cultural attitudes emerged as a primary obstacle, with 56.7% of urban residents adhering to traditional beliefs regarding waste disposal. This perspective fosters a tendency to dispose of waste irresponsibly, reflecting a lack of community engagement in recycling initiatives and sustainable waste management practices. Another critical barrier identified is the inadequacy of waste disposal sites, with 80.6% of the surveyed population expressing dissatisfaction with the availability of proper waste dump sites. This deficiency exacerbates waste accumulation in public areas, further complicating management efforts. Moreover, the study revealed that 51.0% of the community demonstrated poor waste segregation practices, indicating a need for enhanced educational initiatives aimed at promoting source separation. Weak policy frameworks and enforcement mechanisms were also prevalent, as indicated by 64.5% of respondents. Many residents voiced concerns that individuals who illegally litter are rarely penalized, suggesting a lack of accountability and insufficient oversight by relevant authorities.



Source: Fieldwork, 2024.

**Figure 5.** Effective waste management barriers in Nkongsamba.

Insufficient funding was another notable barrier, with 54.8% of respondents

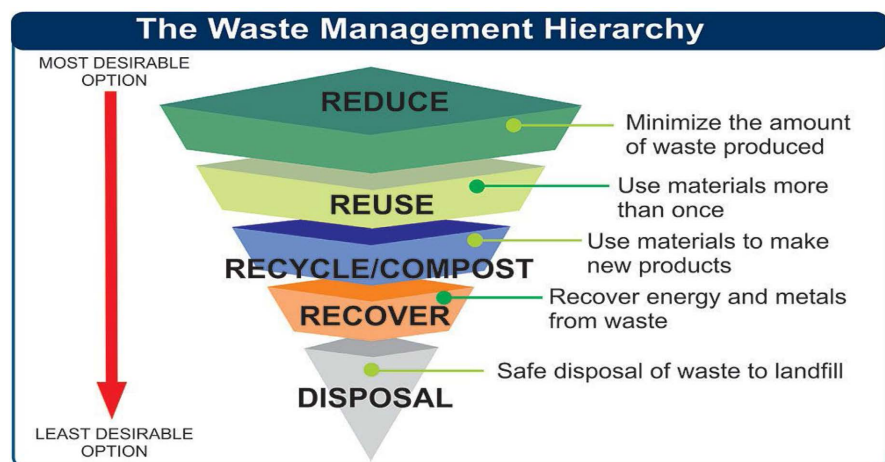
indicating that limited financial resources constrain the development and sustainability of waste management programs. This financial shortfall impedes the implementation of effective strategies and infrastructure improvements. Compounding these issues is the evident lack of public awareness regarding the benefits of recycling, which led to 58.7% of residents exhibiting low participation in waste management programs. Finally, inadequate infrastructure was a pervasive challenge, with 76.1% of the population reporting a significant absence of effective waste collection systems.

#### 4.3. Sustainable Development Approaches to Waste Management in Nkongsamba

The Sustainable development approach adapted in this study incorporate the Brundtland Report by the World Commission on Environment and Development. The report defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” This definition re-awaken city authorities on the necessity for current practices that can safeguard the cultural integrity and living standards of societies for future generations. It emphasizes the interconnectedness of economic, social, and environmental dimensions, which must be balanced to achieve long-term sustainability.

The extent to which countries can attain sustainable development varies significantly, influenced by diverse factors such as geography, economic resources, cultural contexts, and political frameworks. While wealth and advanced technology may provide industrialized nations with advantages in pursuing sustainable practices, the complexity of sustainable development means that these factors alone do not guarantee success. For instance, a wealthier country may still face challenges related to waste management due to insatiable consumption patterns or ineffective regulatory frameworks, demonstrating that sustainable development is not solely a function of economic status.

As seen in **Figure 6**, fundamental principle of sustainable waste management is



**Figure 6.** Waste management hierarchy.

adherence to the waste hierarchy, which prioritizes waste management strategies according to their environmental impact. Every waste disposal option has consequences for the environment, making waste prevention the most effective approach.

This principle places waste prevention at the pinnacle of the hierarchy, followed by material reuse, recovery techniques (such as recycling, composting, and energy generation from waste), while landfill disposal and incineration occupy the least favorable position at the bottom.

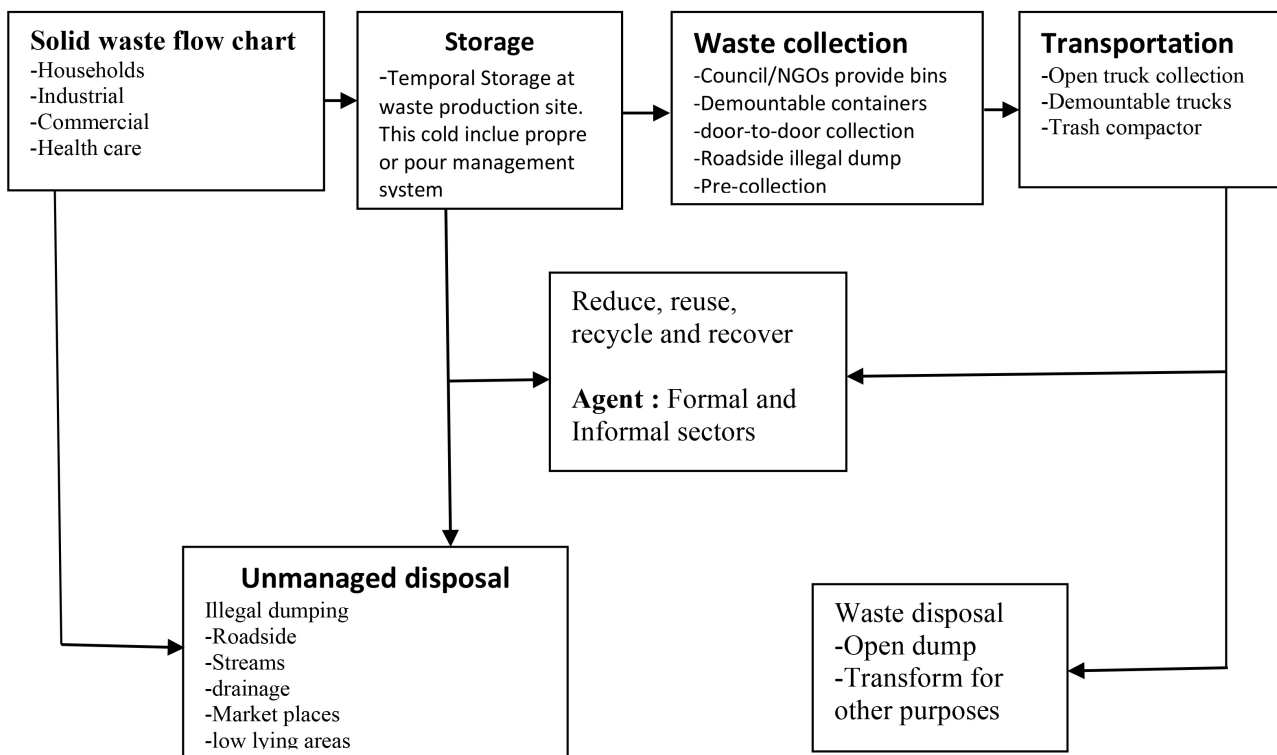
The Waste Management Hierarchy serves as a framework to guide efforts in reducing waste through a systematic prioritization of management options. By categorizing waste management practices from most to least environmentally friendly, the hierarchy assists decision-makers in evaluating and selecting the most sustainable strategies. The hierarchy begins with:

- Notion of waste reduction. City authorities must seek ways to prevent waste, which focuses on minimizing waste generation. The Prevention strategies often begin with product design and the manufacturing phase, emphasizing the importance of creating durable and reusable products. Encouraging consumers to extend the lifespan of products and minimize waste generation. This leads to cost savings in waste collection and processing. Also, regulatory measures targeting excessive packaging in consumer goods can significantly decrease household packaging waste, which constitutes a substantial portion of municipal waste.
- Reusing products and materials. This is the next best priority in the hierarchy, involving processes such as checking, cleaning, repairing, and refurbishing items or spare parts deemed as waste. Prior to reuse, an assessment of material quality is essential, as minor repairs may be necessary to meet safety and functionality standards. Recent studies indicate that approximately one-third of materials arriving at recycling facilities can still be reused, with estimates suggesting that at least 25% of electronic waste possesses significant potential for reuse.
- Recycling. This encompasses the collection, separation, and processing of waste into new products. For example, paper waste like newspapers are frequently recycled into new paper products or eco-friendly insulation materials. Composting involves a similar process for organic waste, such as converting food scraps into fertilizer. Although both recycling and composting processes require energy inputs, they are generally more cost-effective and environmentally beneficial compared to producing new products from raw materials. To optimize resource recovery, recycling of construction waste should ideally occur close to its source, given the weight and bulkiness of such materials.
- Recovery. This mostly concerns energy recovery from waste, while beneficial, typically generates less energy than reuse, recycling, or waste reduction strategies. Recovery processes include anaerobic digestion, incineration, gasification, and pyrolysis, which convert waste into energy (fuels, heat, and power) and

valuable materials. When recycling is unfeasible, identifying alternative recovery options becomes critical to prevent materials from being sent to landfill.

- Disposal. This can be considered a last resort within the waste hierarchy. Therefore, efforts should focus on diverting waste away from this endpoint. In the European Union's sustainable waste management framework, landfill disposal and incineration without energy recovery are classified as the least desirable methods, emphasizing the importance of diverting waste from these endpoints in pursuit of sustainable practices.

While the waste management hierarchy is effectively implemented and practiced in developed countries, developing nations continue to face challenges in adapting these strategies to their specific frameworks. In the context of Nkongsamba, effectively applying the Waste Management Hierarchy (WMH) requires tailored strategies that address local challenges and resources. Waste Reduction should be prioritized by engaging local manufacturers to design durable and sustainable products. Community awareness campaigns can promote responsible consumption and discourage over-packaging, reducing waste from the outset. Reusing materials can be fostered through initiatives like repair workshops and local buy-back programs, encouraging the community to assess and refurbish items instead of discarding them. This not only extends product life but also generates local employment. Recycling programs should focus on establishing collection points for common recyclables, such as paper and plastics. Collaborations with local organizations can facilitate recycling education, making it easier for residents to separate waste



**Figure 7.** Existing patterns of solid waste management processes in Cameroon.

effectively. For recovery, local authorities can explore anaerobic digestion of organic waste to generate biogas, providing a renewable energy source. Lastly, disposal should be minimized through the development of landfill diversion strategies, emphasizing the importance of reducing waste sent to landfills. This holistic approach is necessary to enhance the sustainability of Nkongsamba's waste management practices.

The urban council of Nkongsamba at the moment utilizes a simplified framework pattern of solid waste management adopted in Cameroon (Figure 7). The flow chart begins with actors of solid waste production, the waste produced is temporally stored in mobile bins before moving to depot centers. The waste is then collected by council vehicles, or special services from the depots and sometimes from door-to-door collection where it is transported by council trucks to recycling sites. Most of the waste as in the case of Nkongsamba is deposited at landfill while others illegally thrown into streams and gutters.

## 5. Conclusion

The increasing emphasis on sustainable solid waste management as a vital component of sustainable development has captured the attention of policymakers. In low-income cities like Nkongsamba, Cameroon, waste management primarily relies on landfilling, burning, and composting. However, achieving a sustainable solution is challenging due to the numerous and diverse stakeholders involved, each with differing perspectives on the local waste management system and the absence of effective recycling initiatives. This study spots out critical issues within Nkongsamba's waste management framework. The analysis reveals a fragmented approach to waste management in the city. We gathered and evaluated the opinions of a significant number of households across various sectors involved in waste management and got significant feedback. The findings identify two key areas emphasized by stakeholders in their waste management efforts: the practices surrounding waste generation, collection, separation, and treatment; and the barriers to effective waste management in Nkongsamba. Field findings highlight a myriad of challenges confronting stakeholders involved in waste management practices. Notably, cultural attitudes, inadequate waste dump sites and collection systems emerged as a primary obstacle. Despite efforts in waste management, considerable challenges arise, as only a small fraction of the total waste generated is collected, exacerbated by factors such as population growth. Proactive planning is essential to mitigate indiscriminate disposal and other harmful practices, which can lead to the accumulation of open dumps and create breeding grounds for rats and other vermin, posing health risks. The concept of sustainable waste management advocates for a decision-making methodology that includes all community stakeholders. This approach outlines the development, evaluation, and implementation of a comprehensive waste management strategy. Stakeholders in Nkongsamba are encouraged to adopt this concept to enhance waste management effectiveness in the region.

## Conflicts of Interest

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

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