



Reactualizing the Sustainable Impacts and Challenges of Municipal and Health Care Solid Waste Management Practices in Douala 4 Council Area Cameroon

Nkwenti Peter*

Faculty of Medicine and Pharmaceutical Sciences, University of Douala, P.O
Box-2701, Douala, Cameroon

***Corresponding Author:** Nkwenti Peter, Faculty of Medicine and Pharmaceutical Sciences, University of Douala, P.O Box-2701, Douala, Cameroon.

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Abstract

The growing urbanization and health care facilities has intensified the challenges on municipal and health care waste management. Thus, the study aims to understand waste management practices, identify key challenges, and uncover opportunities for sustainable recycling and resource valorization across the Douala IV council area. "Health facilities", as an approach to address environmental challenges and to meet communities need in health issues. In this approach, all the environmental aspects of municipal waste management are important and to be addressed. Health care and municipal administrators can manage wastes disposal through composting, recycling and better supplying methods. This study is a review of the subject matter, in nature, using many library and online sources; it discusses about the need to move towards the healthcare and municipal waste management approach, the administration and leadership role in its establishment, the environmental impact of health care operations and assessment of the effects, wastes management and recycling, and also the methods in wastes treatment and disposal. The findings are categorized into key themes as waste composition and current practices (biodegradable waste, with limited segregation at source), role of the informal sector in collection and recycling, resource valorization to create training and economic opportunities, socio economic impacts, innovative practices and challenges (weak municipal services, inadequate infrastructure, limited community awareness, and fragmented policy enforcement hinder progress). Turning waste into wealth in Douala IV council demands efforts coordinated efforts among healthcare administrators, policy makers, communities, and entrepreneurs. With strategic support, localized innovations, and inclusive governance, waste can become a good source for sustainable development.

Keywords: Impact; Challenge; Solid Waste Management; Sustainability; Douala IV Council

Introduction

We are at a moment when the dual crises of public health and the environmental issues are emerging, and the place where these two destructive powers are intersecting. Since these two occur together, the cross flow of incoming diseases and deterioration of environmental conditions are becoming increasingly turbulent and changed to destructive forces which are departing the fabrics

of our communities. The increasing production of waste from municipal councils and healthcare facilities due to urbanization contributes to climate change and increase in diseases hence increase mobility and mortality. Pollution and using unsustainable resource are intensifying diseases throughout the world (Najer, *et al.* 2024) these growing problems in environmental health section have affected the healthcare systems very intensely, where

the healthcare sector is contributing paradoxically in intensifying many environmental problems, at the same time, while forcing to deal with the related effects emerged. Healthcare sector, due to the application of products and technologies, resource consumption, waste production and its daily constructions and operations, is a significant source of pollution all around the world, and so helps the public health endangering process unintentionally (Raman, *et al.* 2024). While the hospitals responsibility is to treat the patients in their “wall”, they are also responsible for ensuring that their activities in the “wall” improve the health of our customers, employees and environment (Peralta, *et al.* 2021). Waste disposal and collection of the special centers like hospitals and healthcare centers is of significant importance, due to the potential risks to human, animals, plants and the environment health. Wastes generated during care activities have more potential risk of infections and injury than municipal and household waste (Bank, 2013; Dangi, *et al.* 2011). It seems that some of the municipal production of wastes in medical and clinical centers, which is called specific wastes or clinical wastes, have not been noticed and cared about significantly, especially in developing countries (Maharjan and Lohani, 2020). Many environmental issues in health sector directly associated with the waste production and disposal methods. Hospitals around the world are facing problems in the process of becoming a sustainable environment, and evidence indicates that developing countries are incurring more barriers in this field. One of the main barriers is the lack of necessary infrastructure in hospitals to handle hospital waste disposal. The definition of going green included waste reduction and energy and resource conservation [4]. As Florence Nightingale stated, environmental health is regarded as a key issue raised in the moving towards Green Hospital. Also as Satler said, in the view of Institute of medicine (IOM) specialists, environmental health is to get rid of diseases or injuries caused by toxic factors, agents and other environmental conditions, potentially important for human health [5]. It includes characteristics such as strategic location, efficient use of water, energy and air pollution, the use of fine materials. It can produce other products, keep indoor quality, and provide good food and green environment as well. It has orientation for green products, non-toxic environment, green cleaning, and reduction of waste and provides a healing garden [6]. It is particularly within the context of developing nations that face unique challenges. In this regard, practices such as recycling and resource valorization have surfaced as innovative and transformative methodologies

aimed at tackling these pressing issues by converting waste materials into value- added products, thereby aligning seamlessly with the foundational principles of the circular economy [7]. By prioritizing resource efficiency and waste reduction, these strategic approaches play a pivotal role in facilitating the attainment of the Sustainable Development Goals (SDGs), with particular emphasis on SDG 12 [8]. This particular approach places significant emphasis on the transformation of waste materials into valuable products, thereby not only alleviating the environmental burden but also enhancing economic opportunities and benefits for communities [9]. Municipal Solid Waste (MSW) is largely composed of organic materials, which predominantly include food waste, agricultural residues, and various biodegradable substances that collectively contribute to the waste management dilemma [10]. Traditional waste management practices in Douala IV council face significant challenges, primarily due to ineffective collection, transportation, and disposal methods. The current systems largely rely on landfills, with a substantial portion of waste being inadequately managed, leading to environmental and health issues [11]. Organic waste constitutes about 60% of the total waste, while recyclables like plastics and metals make up around 25% [12]. Traditional approaches have failed due to a lack of community engagement and awareness, leading to resentment and ineffective monitoring of waste management systems [13]. Despite these challenges, some studies suggest that alternative methods, such as waste-to-energy technologies, could provide sustainable solutions for waste management in Douala IV council [14]. The contemporary global focus on waste management has undergone a significant transformation, gravitating increasingly toward circular economy paradigms that advocate for recycling and resource efficiency optimization across various sectors [15]. Empirical investigations demonstrate that effective waste management methodologies substantially reduce environmental pollution while generating economic advantages for communities and industries. The circular economy framework has emerged as an essential foundation of sustainable waste management practices, focusing primarily on closing material loops through systematic recycling and resource valorization initiatives [16]. Strengthening institutional capacity and fostering collaboration between government agencies, private enterprises, and community organizations could address these issues. Policy innovations, such as waste segregation at source and incentives for recycling businesses, have been successful in other countries and could be adapted to Nepal’s context. Additionally,

integrating waste management into national development plans and aligning it with the SDGs can provide strategic direction for achieving sustainability [17]. However, the lack of source segregation remains a major hurdle [18]. The government's efforts to improve waste management have been limited by weak enforcement of policies and insufficient public awareness. Despite these challenges, community-led initiatives have shown promise. Recycling is a critical component of resource valorization, enabling the transformation of waste into valuable products. Recent research highlights the importance of integrating traditional recycling practices with modern technologies to enhance efficiency. Highlights that community-based recycling initiatives can significantly improve waste management outcomes, particularly in low-income countries. Existing studies often overlook critical aspects such as inadequate infrastructure, poor policy enforcement, and low levels of public awareness. The research identifies critical gaps in Douala IV council current waste management system, including inadequate infrastructure, policy enforcement, and public awareness. Moreover, the informal sector's role in recycling and its socio-economic implications remain underexplored. Our focus in this study is on the reactuating the sustainable impacts and challenges of municipal and health care solid waste management practices in Douala 4 council area Cameroon. The respondents were working in different sections of the HFs, NGOs, Douala IV council.

Methodology

Study area

The study was conducted in selected HCFs NGOs, Douala IV council municipalities of littoral region in Cameroon.

Duration of the study

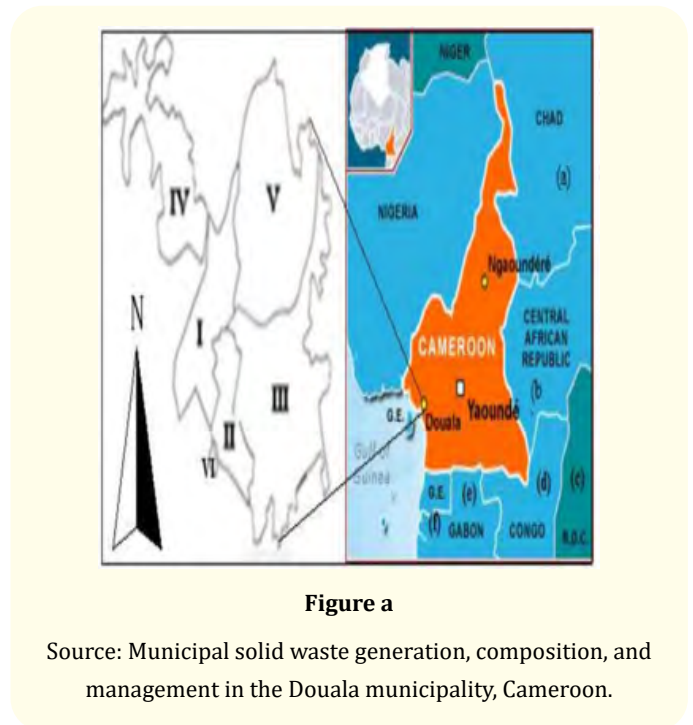
A period of 2 months from 25th August to 30th October.

Study population

- HCFs
- NGOs

Study design

A cross sectional survey with data obtained from HCFs, NGOs, Douala IV municipality identifying impact and challenges of solid waste from August to October.



Discussion

Political instability in the country, especially after the 2025 Presidential election contributed in some measure to poor environmental management of solid waste. The successive governments were engaged in the intra and extra political disputes, paying less attention to infrastructure development and environmental management. There was little political commitment to resolve the crisis.

Municipal solid waste

It's the non-hazardous, everyday waste generated from residential, commercial, and institutional sources, including households, businesses, and public areas. It encompasses discarded items such as food scraps, yard trimmings, furniture, clothing, packaging, and recyclables like paper, plastic, and glass. MSW is typically collected and disposed of at landfills or incinerators, and it does not include industrial, hazardous, or construction and demolition waste.

Healthcare solid waste

It's any solid waste generated from healthcare facilities that can be hazardous, including sharp objects, contaminated materials,

and general waste like packaging and paper. It is a mix of hazardous “healthcare risk waste” and non-hazardous “general waste”. Examples of hazardous waste include used syringes, bandages, and

human tissue, while general waste includes items like office paper and plastic packaging, as long as they are not contaminated.

Hazardous waste	Non-hazardous waste
Infectious waste: Materials suspected of containing pathogens that can cause disease. Infectious sharps: syringes, needle, scalpels, and broken glass. Infectious non-sharps: blood-soaked bandages, swabs, and gauze. Pharmaceutical waste: Expired or unused medications, vaccines and other drugs.	General waste: Waste from healthcare facilities that has not been in contact with infectious agents or hazardous chemicals. Examples: office paper, plastic, and packaging materials from medical supplies, food packaging, and leftover food

Table 1: Hazardous and non-hazardous.

Similarities between municipal and healthcare waste

Municipal and healthcare waste share similarities in their fundamental process, which includes generation, segregation, collection, transportation, storage, treatment, and disposal. Both systems require a systematic approach to safely handle various waste streams, with an emphasis on separating general waste from hazardous waste and applying appropriate treatment methods before final disposal to protect public health and the environment. Key similarities; Systematic process; both types of waste management follow a series of steps, from the creation of waste to its final disposal. Segregation; separating waste at the source is a crucial similarity. General, non-hazardous waste must be separated from hazardous waste in both systems to ensure safety and appropriate treatment. Collection and transportation; both rely on collection and transportation systems to move waste from its point of generation to storage and treatment facilities. Special equipment and routes are often required for both. Storage; waste is stored in designated areas before treatment. These areas often need to be secure and well-ventilated, especially for hazardous materials. Treatment and disposal; both systems use various methods for treatment and disposal, such as incineration, depending on the waste type. Hazard management; both have to manage hazardous materials. Healthcare infectious, chemical, and radioactive waste, while municipal can contain hazardous materials like batteries or electronics that require special handling. Protection of public health and environment; the ultimate goal for both systems is to protect human health and the environment from the adverse effects of waste.

Impact of municipal and healthcare waste on human health and the environment

On human health

Infectious disease; uncollected municipal (MSW) creates breeding grounds for vectors like rats and cockroaches, which spread diseases. Inadequate waste management facilities, including landfills, can also release pathogens that contaminate air, water and soil. Respiration issues; Waste collection workers are at risk of respiratory problems, chronic bronchitis, and other ailments due to exposure to bio-aerosols, dust, and toxic compound. For the general public, open waste burning releases smoke and harmful particulate matter that can cause or exacerbate lung and heart diseases. Carcinogenic and other risks; exposure to chemical pollutants from landfills and incinerators, such as heavy metals volatile organic compounds (VOCs), is linked to higher cancer risks, especially for workers and nearby residents. Injury and trauma; waste pickers and municipal workers face a high risk of injuries from sharp objects, heavy lifting, and accidents involving machinery or vehicles.

On the environment

Water pollution; leachate, a toxic liquid formed as water passes through solid waste in landfills, can contaminate both groundwater and surface water with heavy metals, organic pollutants, and pathogenic microorganisms. Air pollution and global warming; Landfills release significant amounts of methane and carbon dioxides, which are potent greenhouse gases. Open burning of waste also releases various air pollutants, including carbon monoxide, nitrogen oxides, and dioxins. Soil contamination; the percolation

of leachate from landfills pollutes the soil, affecting its quality and fertility. This can harm ecosystems and contamination crops grown in the area. Aesthetic and nuisance problems; improperly managed waste leads to foul odors, visual blight, and the presence of pests and stray animals, which degrade the living environment.



Challenges on municipal and healthcare waste management

Key challenges include a lack of funding, inadequate infrastructure, and insufficient regulatory systems, which lead to poor collection and disposal. Other issues involve a shortage of trained personnel, weak public awareness or participation, rapid population growth, and the specific dangers of healthcare waste, such as infectious materials and pollution from incineration. These shortcomings result in environmental pollution, disease, and a strain on public health and government.

Municipal solid waste management challenges

Financial and resource constraints; Limited funding is a major barrier, preventing necessary upgrades to collection and disposal facilities. Agencies often lack financial and human resources, especially in developing areas. Population and urbanization; rapid urbanization and population growth outpace the capacity of existing waste management systems, creating a continuous strain. Public engagement and awareness; poor or non-segregation of waste at the source, lack of awareness, and negative attitudes from the public hinder effectiveness. Inefficient operations; services are often inefficient, and there is a lack of technical know-how and initiatives to improve management.



Figure 2: Municipal solid waste management challenges.

Healthcare solid waste management challenges

Infectious and hazardous waste; healthcare waste can spread infections, and its improper handling poses risks to healthcare workers and the public. Cost-effective solution; many healthcare facilities, particularly in developing nations, face financial difficulties and struggle to afford safe and effective disposal methods. Regulatory and staff limitations; A lack of appropriate legislation and specialized, trained clinical staff contribute to mismanagement. Environmental pollution; incineration can release air pollutants, while the overall waste stream from healthcare can lead to environmental damage. Increased waste; events like pandemics can dramatically increase the amount of potentially infectious waste (e.g., personal protective equipment), creating an immediate strain on management systems.



Figure 3: Healthcare solid waste management challenge.

Sustainable municipal and healthcare solid waste management

Sustainable municipal and health care solid waste management involves using a waste management hierarchy that prioritizes prevention and reduction, followed by reuse, recycling, recovery, and finally safe treatment and disposal. Key strategies include implementing integrated management systems, promoting source reduction in municipal and healthcare settings, improving waste segregation and collection, investing in infrastructure and engaging the community through public awareness campaigns. For healthcare waste, this also includes specific measures like the safe disposal of sharps and careful management of pharmaceuticals to minimize both health and environmental risks. Key strategies for sustainable waste management. Implement the waste hierarchy prioritize waste prevention, reduction, and reuse, followed by recycling, recovery (example, waste-to-energy), treatment, and then final disposal. Promote source reduction for healthcare, this include selecting less harmful pharmaceuticals and proper disposal methods for items like syringes. Municipal efforts can include life cycle assessments for products and policies that discourage waste generation. Improve waste segregation; at the source, waste should be meticulously sorted to separate recyclables from hazardous materials, making subsequent processing more efficient and safer. Enhance collection and infrastructure; this include investing in efficient collection services and specialized activities for sorting and processing waste, especially for hazardous materials. Engage all stakeholders; successful systems require collaboration between government, private companies, and the public. Community awareness and public-private partnerships are crucial for fostering a sense of responsibility. Ensure proper training and safety; provide proper equipment and training for waste workers to protect them from injuries and health hazards, especially when handling medical waste. Focus on both municipal and health care waste; these are interconnected, as seen during events like the pandemic where home-generated medical waste increased municipal solid waste significantly. Develop policies and financial models; clear regulations, proper financial planning, and revenue generation from waste systems are essential for long-term sustainability.

Proposed solution for municipal and healthcare solid waste management

Proposed solution for municipal and health solid waste management include comprehensive waste reduction and recycling

programs, using advanced sorting and treatment technologies like AI and thermal treatment, and shifting to a circular economy model. For healthcare waste, specific solution involve improved segregation, proper labeling, and safe containment and transport of risk waste.

Municipal waste management

Waste reduction and recycling; implement comprehensive recycling programs and promote waste reduction and reuse at the source., advanced technologies; utilize advanced waste sorting technologies and explore artificial intelligence (AI) for predicting performance in generation, segregation, and treatment., circular economy; integrate waste management into the circular economy by focusing on resource recovery and waste minimization., sustainable disposal; optimize landfill practices and consider thermal treatment method for waste that cannot be recycled or reused, public -private partnership; leverage public-private partnerships to support and fund better waste management systems. Community engagement; increase citizen participation through education, awareness campaigns, and community-based interventions that encourage proper separation and delivery of waste.

Healthcare waste management

Segregation and labeling; improve waste segregation at the source using standardized color-coding system for different waste types (e.g. infectious waste, sharps, general waste). Waste minimization; improve waste minimization, avoidance, and reuse strategies within healthcare facilities. Proper containment and transport; ensure waste is properly contained in labeled bins and safety handled, stored, transported to treatment facilities. Waste audits; conduct regular waste audits to monitor and assess the effectiveness of waste management plans. sustainable design; incorporate sustainable practice and technologies into the design of new healthcare facilities to reduce waste generation from the start.

Effective municipal and healthcare solid waste management

Effective municipal and healthcare solid waste management requires a multi-faceted approach that prioritizes waste reduction and segregation. Key components include implementing modern disposal technologies like waste-to-energy facilities and sanitary



Figure 4: Proposed healthcare solid waste management.

landfills, improving infrastructure and funding, and ensuring that both healthcare and municipal waste workers are properly trained and equipped with safety gear. A lack of comprehensive policies, inconsistent funding, and poor public awareness and compliance remain significant barriers to success, highlighting the need for stronger governmental action, better public education, and improved methodologies in waste management practices.

Conclusion

Regardless of location, type of habitation, the solid waste management (SWM) sector is complex and requires multiple aspects to work in synergy in provide efficient services, protect public health, and conserve the environment. In low-and middle-income countries, it is all the more challenging because SWM requires significant prerequisites. These prerequisites include local government capacity, institutional coordination, stakeholder cooperation, sustainable funding mechanisms, infrastructure, technical knowledge, public awareness, behavioral change, monitoring and enforcement, data collection and analysis, and relevant laws and policies. The uniqueness of mountain areas to the challenges of managing solid waste in high-altitude areas.

Waste type	Household waste generation				Institutional waste generation			
	KTM	PKR	BTL	DNG	KTM	PKR	BTL	DNG
Degradable	64.24	62.65	74.60	78.60	20.29	26.19	24.48	16.36
Non-degradable	34.69	35.27	21.1	29.22	76.36	73.49	52.15	71.47
Others	1.15	1.63	4.30	2.65	3.35	0.32	23.37	12.17

Table 2: Waste generation and institutions (in percentage).

Source: (Maharjan., et al. 2019).

Participant	Response
Municipal officials	Every day, we are seeing more electronic item being discarded, and we are not yet prepared to manage this growing waste of this categories
Community leader	The initiative is there, but people still need more motivation and facilities to separate waste at the source.
Youth group leader	We have been able to create a model neighborhood where majority households now separate their waste
Policy maker	We want to introduce recycling programs, but there is a lack of technical expertise and resource at the municipal level.
NGO Member	We have started door-to-door awareness programs, and people are responsible positively, but we need stronger backing from the municipality

Mayor	Turning waste into wealth is not just a slogan; it must be the strategy for our future urban development.
Woman’s group	With composting, we not only reduce waste but also produce organic fertilizer for our gardens
Social entrepreneur	If we get stable supply chains and easier licensing processes, recycling business can thrive and create jobs.

Table 3: Opinion of participants toward waste management.

Participant	Response
Municipal officials	Every truck that arrives at the landfill is loaded with biodegradable waste that could have been composted at the source. We are literally burying opportunities every day.
Community leader	Most of our waste is kitchen waste. If we had better composting facilities or support, half the waste would never reach dumping site
Waste management officer	People are aware of the need to separate waste, but the lack of convenient systems and incentives discourage them from doing it daily. We want to introduce recycling programs, but there is a lack of technical expertise and resource at the municipal level.
Youth group leader	In our community, household are given separate bins for organic and non-organic waste. Monthly competition for the best segregated household have created excitement and real change.
Policy maker	Segregation is promoted through posters and community meetings, but without regular monitoring and collection systems, it become difficult for households to maintain the practice.
NGO member	We have started door-to-door awareness programs, and people are responsible positively, but we need stronger backing from the municipality.
Social entrepreneur	Segregation is the first step, but unless there’s a system to process separated waste, people lose motivation.

Table 4: Opinion of participants towards waste segregation.

Participant	Response
Municipal officials	Without the informal workers, our landfills would overflow much faster. They are doing essential work but remain outside formal recognition
Sanitation worker	Every morning before the municipal trucks arrives, we collect plastics and bottles. It’s how we survive, and it also helps the environment, but nobody sees us.
Community leader	leader If we formalize the informal sector, provide them training, tools, and dignity, we can transform waste management in Cameroon
Policy maker	We see them working every day, but there’s no formal system to engage them. It’s an opportunity we have yet to properly harness.
NGO Member	We recently mapped informal waste collectors, and though small in number, their potential to support recycling efforts is huge
Social entrepreneur	We depend heavily on the supply from informal collectors. They bring in clean, sorted materials that are ready for processing

Table 5: Opinion of participants towards role of informal sectors.

Participant	Response
Environmental activists	With the right investment in technology and training, resource valorization could create hundreds of green jobs, especially for youth and marginalized groups
Policy maker	Waste should no longer be seen as a liability but as an asset that can fuel entrepreneurship and innovation. Municipalities must provide an environment where recycling businesses can thrive
Women’s group leader	We learned how to make bags, mats, and baskets from plastic waste. It’s not just income it’s also pride in protecting our environment
Business owner	Recycled plastic is now used to make durable roofing sheets and paving tiles. It’s cheaper and sustainable, but we need more incentives to expand productio
Scrap dealer	We could create jobs and income if we had machines to better process scrap, but capital is a big barrier.
Social entrepreneur	From just organic waste collected in three wards, we produce over 2 tons of compost monthly, which we sell to local farmers. Demand is high, but supply systems are inconsistent

Table 6: Opinion of participants towards resource valorization and economic opportunities.

Participant	Response
Policy make	If we integrate waste valorization into our local economic development plans, the benefits could multiply but we have to act now.”
NGO	The biogas system in one ward now supplies gas to 15 households. It saves them money and improves their quality of life
Women’s group leader	Before, many women were dependent on seasonal work. Now, by making eco-products from waste, they earn year-round and contribute to their families’ stability
Business owner	Learning how to turn waste into eco-products gave me the skills and confidence to start my own small business. It’s a path I never imagined before We can create jobs and wealth, but without consistent demand and policy support, it’s hard to sustain growth
Scrap dealer	Recycling scrap metal and paper is not glamorous, but it feeds my family and pays for my children’s education.
Social entrepreneur	We have created over 30 stable jobs, many for people who previously relied on uncertain daily wages. Valorization offers dignity along with income

Table 7: Opinion of participants towards socio-economic impact of waste valorization.

while SWM challenges may be shared by many types of locations, mountain areas relate to challenge more commonly associated with other eco-sensitive areas rather than their counterparts in the plains.

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