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Examining the Challenges and Opportunities of Waste Management in Cameroon

1. Introduction

Waste management challenges and opportunities in Cameroon are numerous and multidisciplinary issues. The mounting volumes and the distinct changes in household and industrial waste composition have aggravated collection and disposal. Very structured management systems such as eco-taxes, the recycling industry, and composting practices are less efficient or virtually non-existent. This paper investigates the social and technological aspects of waste management. In discussing the particulars of waste management in Cameroon, the paper delves into a conceptual foundation to understand why eco-taxes or privately owned waste management strategies may be less effective. The paper assumes that strategies aimed at controlling waste may be better embraced by the public when eco-dumping measures stifle environmental degradation symptoms.

Cameroon is a least developed country that is facing the growing challenges of waste management. The protracted financial crisis, the continuous population growth, and the rising aspirations for a better standard of living have combined to alter the composition and the quantities of urban waste produced. Similarly, the segmentation in the composition and number of hazardous classes of industrial waste has changed. These worries have resonated far beyond the main cities of the country. Three dramatic fires in the prominent municipal dumps have alerted the authorities and citizens to the potential social, financial, and technical health risks that the growing volumes of offensive and malodorous waste may hold. This has generated a widespread appeal for a better-controlled waste transportation and disposal system. This paper briefly critiques the management of industrial and household waste. It claims that the country must carefully decide between well-thought-out private-based and tax-based waste management institutions to make acceptable strides in waste management.

2. Historical Overview of Waste Management in Cameroon

Managing waste in Cameroon is a common challenge faced by most municipalities in the country. These municipalities found themselves confronted with the difficulty of managing the rising volume of waste while ensuring environmental protection and public health. The change brought about by industrialisation, urbanisation, and rapid population growth led to increased waste generated and presented a challenge to service provision. In the 1970s, the only waste management system that existed was operated by the colonial administration, and even though some waste was being generated, it was not much of a public concern like today.

Public concern about waste management increased in public policy and academic discourse, especially after the economic crisis of the 1980s. Cities in Cameroon started witnessing environmental degradation due to the lack of effective waste management systems. One of the visible impacts of the crisis on urban areas was the disruption in mortuary services, indicating the absence of regular and compelling collection of waste in the city centre. This situation alarmed local authorities to develop solid waste management services. As a result, different waste management systems now exist to respond to the challenge, but individuals run them in the so-called informal sector. Since then, there has been an increase in the attention given to waste management as the growing population and increasing urbanisation have led to considerable growth in the health and environmental effects associated with practices in waste management.

3. Current State of Waste Management in Cameroon

In African cities, where refuse is mounting, waste management is not meeting efficiency, effectiveness, and innovation standards. Sometimes, waste management is not at the top of political agendas, or at least not to the point of generating concrete actions. Urban public hygiene in some cities can hardly hide these visions. The challenges in terms of treatment, valorisation, and, finally, financial and technical resources remain enormous. The problem of waste management and its consequences in the concerned cities stems essentially from the failure of the public authority at the global, national, and local levels to ensure proper urban governance and management and to meet the needs of the growing population. This imbalance affects national and regional authorities equally, albeit in different ways.

This failure is usually attributed to two fundamental problems: insufficient financial resources and questionable techniques that have not been put in place or

already exist but are not functional. Among the signs of waste management dysfunction in some cities, and in particular, are the absence of a rational waste collection system, such as the door-to-door service, and the presence of informal workers who often provide this service through their income-generating activities. The management strategies put in place by the town halls of these cities, through their collection poles or ad hoc committees, have been inadequate. Another strategy the town hall implements is introducing a door-to-door system in some neighbourhoods. However, this service does not benefit most of the city's population.

3.1. Infrastructure and Resources

Given the consistent increase in urbanisation and the rapid growth in the use of plastics globally, managing solid and liquid waste within urban areas in developing countries is becoming a growing concern. Cameroon faces numerous challenges due to increased population, resulting in increased waste generation and changing compositions. In Cameroon, these issues are particularly acute for commercial cities like Douala and Yaoundé and beach and desert areas like Limbe, Kribi, and Maroua. As a result, waste management presents a significant opportunity to introduce job opportunities in a country with high youth unemployment. This study examines the barriers to effectively managing waste in Cameroon. We further describe the various strategies implemented to alleviate the burden of poor waste management practices in the country. While these practices may conserve substantial environmental costs, they have ecological and potential health risks.

The challenges in discussing this issue are enormous. Securing financial resources, creating institutional capacity, and providing management expertise to help find solutions to infrastructure challenges have been elusive. The fast-paced growth of the population is contributing to inadequate infrastructure supply in urban areas. The low-income groups in urban and rural areas feel this, as they rely primarily on public infrastructure services. The low influx of funding, high corruption, and the weakness of implementing, operating, and maintaining public infrastructure projects are of great concern. With human capacity and management expertise proving tardy, infrastructure maintenance has become a challenge since most public infrastructure does not last for the stipulated time intended by the designers. After initial operations, the community infrastructure is abandoned and hardly maintained as the responsibility for preserving it is either not assigned or unclear.

3.2. Regulatory Framework and Policies

Municipal and industrial waste collection, treatment, and landfill management are under the responsibility of local councils in Cameroon. Collecting economic waste, mainly used tyres, is the responsibility of companies and other service providers. Until now, national officials have not considered sanitation issues a priority. Respondents believe that the lack of political will and strategies are two critical factors responsible for difficulties in implementing the legal and regulatory frameworks. Such lobbying has led the government to adopt the principles and structures of sectoral policies and regulations from other countries. Nevertheless, a national delegate is responsible for coordinating and orienting waste activities in both countries. On the one hand, for waste monitoring, it is estimated that a generator of waste must keep an environmental monitoring register for at least three years and communicate annually to the Head of Sanitation in the city where the generating operation is located, under the conditions laid down by the government. Sanitation service performance contracts deal, in particular, with managing non-suspended waste. They are designed to serve as a reference for delegating to the municipal public companies in charge of house-to-house collection and vacuum sweepers. In practice, the lack of coordination between the signing of contracts and the actual operation of the service is a recurrent problem. The pay-for-service principle is intended to limit the private sector's financial risk. Household customers quickly learned how to handle this concept since the bill for payment began to recover 100% of the amount. Finally, they led to a lease agreement between the contractor and the local authority.

4. Challenges of Waste Management in Cameroon

Although government authorities and partner organisations have made significant progress, multiple challenges must be overcome in waste management to achieve the desired objectives. Sanitation and waste management systems generally have consistent weaknesses, particularly in developing countries. Hence, the first challenges identified are institutional and regulatory. Economic, socio-cultural, and technological difficulties follow this. Each of these is explored in detail below. Cameroon’s legal framework aims to implement waste management plans formally. Specifically, it addresses waste generation, handling, and eradicating unauthorised waste disposal. Such measures encourage the creation of state institutional governance. However, the institutional and regulatory framework is globally undermined by the ineffective performance of noninterference.

Commercial companies' desire to obtain the most significant profit has led to the non-existence of clear responsibility. As a result, it is challenging to balance the benefits of public and private resources. The economic system of government pushed tariffs so low that only ten per cent of the expenditures were paid on accounts and had to be subsidised from taxes. Concurrently, municipal councils are not active in regulating the informal and traditional sectors, which are opportunistic, fast, and cheap in waste management. The impact of poorly managed waste holds great appeal. However, local government units are burdened with a high volume of dirty waste. Furthermore, waste collection logistics are impractical. The brigades lack the necessary experience or expertise and do not satisfy the conclusions.

4.1. Lack of Public Awareness and Education

Because of the recentness of the country's public awareness on this subject, combined with sometimes retrogressive beliefs of sanitation as satanic and representatives of Satan, especially concerning the deceased, there is a high potential for conflict. Similarly, the local integration of public awareness instruments is very slow; one notices the absence of practical instruments on the ground. They are generally too general or complex to carry out if one does not have a certain degree of knowledge. Despite a few associations that work well on the spot, there is a low level of public awareness. There is a real lack of consciousness among populations concerning ecological phenomena. This does not facilitate sensitivity, understanding, teaching, application, and maintenance of clean water sources.

This current national public awareness, limited as it is, is now widely known by the ubiquitous void of the Sabbath of the podium in the sunny underground—like the theatres were, with at the end of the performance a visit to standardised, but not with the long-standing information and throughout the year of appropriation of what was presented. Indeed, despite a good investment in this form of advertising and continuous mechanical repetitive shattering, they are generally disconnected in cycles. We should excessively remind the population of something to keep their memory and information in everyday life. Otherwise, we could always make summaries whenever we wanted to and, at any time, reinvent scribbling summaries in times of need. The general end communication is broadcasting in camouflage; we could quote phrases that are both repetitive and public: "the clean water, of course," "hard and beautiful water," and "as soon as

you have found drinkable water, you will protect it at any cost." All exist in lyrics parodies composed by folkloric groups.

4.2. Inadequate Infrastructure and Technology

Inadequate infrastructure and technology constitute a significant challenge to proper waste management in Cameroon. Municipal solid waste management in Cameroon is primarily carried out by individual citizens and communities, who gather waste and transport it to places such as dumpsites and the edges of urban areas, which are slowly transforming into illegal landfills, often in susceptible urban land. The improper disposal of waste causes it to be found everywhere, far from the collection points. The unavailability of waste collection points in some areas causes the population to transport waste several hundred meters away into the bushes to ensure the vicinity is free from dirt. The lack or inadequate number of waste storage equipment like bins, buckets, and hoppers creates the sense that they are unnecessary. Limited access to proper waste storage facilities for various materials generates illegal dumping at roadsides, curbs, street corners, forests, and illicit landfills near the urban perimeter. While people living in rural areas can quickly bury waste, those in urban areas with poorly designed or absent infrastructure may find temporary solutions, such as acquiring secondary waste disposal containers, dumping waste, burning, and incinerating waste, which makes pristine places uninhabitable. In almost every study area investigated, some of the existing waste bins are either overfilled, derelict, or spoiled; moreover, some representatives of the local public administration were unaware of some waste collection points. The waste thus tends to accumulate around the collection sites or distribute itself along the roadway or near the nearest homogeneous collection site. The bins are filled anarchically without attention to the type of waste introduced. There is an overall absence of separate collection systems and recycling infrastructure for most waste.

5. Economic Potential of Waste Management in Cameroon

5.1 Recycling Sector Waste management is one of the sectors that can generate a lot of income, aiding the country's potential growth. It is important to note that developing a recycling sector can reduce high unemployment rates because this sector can employ many individuals. 57% of the waste generated in Cameroon is plastic waste. This presents great potential for recycling because plastic waste is more valuable in the recycling markets. This country has market opportunities since almost all the recycled items are imported from other countries. These

recycled items are reused here; therefore, if many Cameroonians understand this, the jobs created in the recycling sector are secured.

5.2 Creating a Market Opportunity Some people will question how and where the waste could come from to secure the market opportunity for recycling facilities. This starts with all responsible people: it begins with urban citizens and then the government, which is meant to create and support programs to provide and recycle waste. These recycling companies are collecting waste from households, regardless of household size. In this case, one of the opportunities created is that being jobless should be no excuse for failing to keep the environment clean.

5.1. The Concept of Circular Economy

The circular economy concept refers to the efficient use and reuse of resources, such that the value of the materials is maintained for as long as possible. Waste generation is thus minimised. Waste management is one of the most significant contributors to achieving a circular economy for materials and resources, including by-product recovery. Circular economy concepts are used at the design stage to ensure products and materials can be remanufactured, repaired, and recycled at the end of their lifetimes. The recycling of resources is reintegrated into the economy, reducing reliance on primary materials and reducing the impact of the waste stream. At its core, a circular economy aims at economic growth with the lowest environmental impact. The ultimate aim is to prevent waste generation and keep materials, resources, and products at their highest possible utility in the economy throughout their lifecycle. More and more companies also see the circular economy as a business opportunity and actively seek options to produce circular products or use waste as secondary raw materials in their production processes. These economic aspects place the circular economy well ahead of waste management and recycling management, as economic aspects are not yet addressed by waste management or recycling but would require a dialogue between production and waste management across company boundaries. The circular economy will allow numerous entrepreneurship opportunities around local product repair, filling, and recycling. Overall, the effects are preventing energy use, air emissions, and greenhouse gases. At the same time, it may allow energy generation from waste when waste is not used directly by the manufacturing industry. At least, it is a new rationale for waste management and recycling and puts pressure on respective legislative changes. However, economic aspects are not yet addressed by waste management and recycling but would

require a dialogue between production and waste management across company boundaries.

5.2. Job Creation and Economic Growth

Ecumenical Development Services/Caritas Cameroon has, through its promotion of waste management by youth entrepreneurship, worked towards several Sustainable Development Goals (SDGs), precisely Goal 2: Zero Hunger; Goal 6: Clean Water and Sanitation; Goal 8: Decent Work and Economic Growth; Goal 9: Industry, Innovation and Infrastructure; Goal 11: Sustainable Cities and Communities; Goal 12: Responsible Consumption and Production; and Goal 17: Partnerships for the Goals. Employment is difficult for the youth in Cameroon, and it is hard to work together to promote waste management businesses. Instead, we offer experiences and incentives to existing and potential young partners through business plans and vocational training. With approved projects, the up-and-coming projects will undoubtedly require time and investment, which can be used in terms of experience, business concept and plan, and labour contribution to secure a stable future. Waste management will provide an agribusiness based on the above waste for current and future conservation and production. It will keep the community healthy and provide a prosperous communal business that keeps the environment clean.

6. Case Studies and Best Practices

The challenges urban authorities face in African countries concerning waste collection and disposal are significant. However, in the face of these challenges, some urban areas manage waste effectively. Several case studies of best practices in waste management illustrate how innovative thinking and implementing appropriate measures transform how municipal solid waste is managed. It is proposed that demonstration events be held with local urban authorities. The results of this research will be disseminated widely and regionally and through the broader international community.

Different environmental guidelines have been developed at the national and international levels, setting technical and standard requirements, and other instruments have been implemented to assess how these cities address waste from both local and global perspectives. These methodologies raised waste production awareness in various geographic and socio-economic contexts, comparing them with their peer groups; however, their effectiveness has been more related to the other application levels and short-term visitors. Local institutions must implement

long-term strategies to ensure sound management, allowing current city residents and future generations to live in a healthy and clean environment.

6.1. Successful Waste Management Projects in Cameroon

Several successful waste management projects in Cameroon have been reported, but almost all are pilot schemes covering only a few towns. However, they have, in the long run, not proved to be commercially viable. Therefore, if Cameroon is to solve the mounting challenge of managing urban waste, its efforts will have to focus on identifying the root causes of the existing situation and determining the steps that must be taken to address them. It is feasible, cost-effective, and possible, especially given a demonstration of willpower and understanding; hence, our work in this book is an assessment of the waste management problems and, in essence, calls for government regulation and private-sector investment in waste management.

Several successful waste management projects have been reported in Cameroon. Unfortunately, all of them are pilot schemes and cover a few towns. The waste management strategy of Mboa, a small private-sector company for waste collection in Yaoundé, is considered one of the most successful operations in the sub-Saharan region. Similarly, it has one of the best waste management schemes. Nonetheless, these towns are small, and their waste management plans are more pilot schemes by any standards. Indeed, the logistics associated with regular waste collection for the Biyem-Assi wet market involve several forty-ton trucks, as opposed to the Toyota van that services the Yaoundé main stadium in an hour. With the increasing number of inhabitants and the volume, especially of non-biodegradable waste generated, premium and secondary towns have not been able to finance any of their waste disposal costs, let alone recover them.

6.2. International Models and Their Applicability

Despite the many shortcomings of current waste management practices in many settings worldwide, including industrialised countries, many relevant examples and models of integrated waste management systems that are cost-effective in both economic and environmental terms are available. Examples include comprehensive waste management and waste-to-energy systems, various infrastructure industrial parks, sewage treatment systems, integrated waste management models, and recycling consortia.

Governments are responding with far-reaching changes in policy and appropriate legislative action. Typically, they are passing the principles of the polluter pays

and the precautionary principle regarding waste and sustainable development into law. They have also set tax incentives for companies that can prove they are minimising waste at source cost-effectively and are investing in machinery to achieve that goal. In the last few years, millions of dollars have been claimed and indeed paid in tax credits to proactive companies. Significant companies are busy installing systems to ensure no waste enters the environment, either as air emissions, soluble or insoluble liquids, or solid materials. The waste and what it was that prompted the regulatory intervention in the first place are beginning to be recognised as valuable with the potential for a generous return on investment. The environment is the primary winner. There is no "away" when it comes to industrial waste disposal.

7. Environmental and Health Impacts of Poor Waste Management

There are several reasons why waste management is essential. The rapid urbanisation of many African countries, including Cameroon, requires rapid solutions to address environmental management problems generated by urban solid waste. The lack of adequate facilities for the collection and disposal of waste in the Bamenda urban area, where the project is situated, poses significant potential risks to the health of the inhabitants. The putrefaction of the waste and lack of drainage gutters frequently lead to the buildup of water laden with decomposing organic matter, leading to the development of conditions favouring various diseases such as diarrhoea, dysentery, and cholera. Poor solid waste collection creates illegal dumpsites in unregulated areas, posing health threats from multiple vermin. This is especially the case for the animals roaming the neighbourhood for food.

Sewer systems are lacking in the area, water availability is low, water systems are all contaminated, and there is a lack of wastewater collection systems, with wastewater mixed up with solid waste. The houses dump their waste into small canals within a short distance from essential churches, schools, institutions of learning, and the people. There is no manure management system, and no house toilets are used. Most people, including those in schools and institutions, use the bushes as toilets. The people live in close contact with the manure in the surroundings, leading to many cases of malaria, diarrhoea, and dysentery. The environmental health committee only focuses on the aesthetics of the road junctions and gutters, while full prevention campaigns remain absent. They remain blind to the main environmental issues, such as constructing inappropriate waste storage bins per house. This is a health risk, as rains carry the waste into the

canals and prevent people from using the canals for drainage and irrigation purposes.

7.1. Air and Water Pollution

Whether at the formal or informal level, waste management practices in Cameroon have several secondary severe environmental impacts on water and air. Uncollected waste accumulates in and around residential areas, forming temporary pathways for rain and industrial runoff movement. This solid waste often tends to follow the overflow into natural streams. Not only does this result in substantial degradation of the water bodies, but it also impairs efforts to pipe clean water to the citizens. The problem is most acute in urban and semi-urban areas where most issued pipes, like roads, exist. In low-income housing areas, water bodies frequently remain the receptacle for human waste and a place for washing. In these areas, temporary, seasonal swamp-like characteristics are created. However, observations made at organised waste dumps show that these pathways made by the washing and the human waste often end up as the sole water source for productive projects.

The transport of bulk solid waste to designated disposal sites, which occupy substantial areas, is a source of considerable air pollution. Except for a few posh upper-class localities in the big cities, waste disposal sites are always on the outskirts of the settlements and sometimes close to or within the industrial compound. Hence, the transportation of this waste pile creates a heavy dust cover coating of the existing vegetation, eventually leading to its oxidation. Furthermore, the long wait imposed on the trucks by clashing at the disposal sites and competition among users leads to the uncontrollable and uncollected release of harmful gas substances into the air. Moreover, wind erosion has become a frequent technique for covering waste, occasionally resulting in fires.

7.2. Spread of Diseases

The presence of mounds of uncollected refuse fosters breeding grounds for flies, mosquitoes, and vectors of aquatic life such as slugs, snails, and harmful bacteria, which is a health hazard to people. Such factors and other issues of waste management have nutrient levels that lead to the spread of diseases, cause stunted growth in children, and weaken the ability of the human and animal body to resist infectious agents. A poorly managed landfill will attract vermin and have odour problems. A well-run landfill will not contain open waste. The water and air quality of surrounding regions may be affected by the lack of control of drinking water and the emission of harmful gases into the atmosphere.

The groundwater can be polluted by measures such as rainwater filtration and leachate collection through more effective design techniques. Community waste collection is critical to waste minimisation, especially in densely populated slums. Maintaining the illegal retention and landfill-like dumps in the settlements is essential to disposing of household waste by the roadside or investing money in public collection services, which pile up around the garbage cans. To deal with the waste problem from industrial sources, the setting requires developing and consolidating national and local authority's capabilities and cost-effective engineering installations for physical collection, processing, separation, recycling, or storage.

8. Social Implications of Inadequate Waste Management

These sections include poverty and social inequality, public health, and risks associated with lacking regional cooperation on waste control in West Africa. We argue that these implications are the limitations of poor waste control, not the amounts of waste produced or the management notions deployed. Worrying about future recycling rates and landfill sites is a luxury; it is more important to ensure that all the citizens of Cameroon live in clean environments and decent social order.

Waste management is not only a physical process but has social implications. When a city environment becomes clogged with waste, and people can no longer move, enjoy public services, and socialise without risking their health, disease and disorder emerge. People in the formal and informal sectors who maintain the public environment in exchange for resources are given extra work, and their communities may become less viable. It should not be forgotten that when public space is transformed in the sense of becoming overcrowded with secondary raw materials, the mineral and the scrap merchant, the scrap dealer, and above all, the army of those who are ready to pull apart or pack up are not the only ones who can circulate.

8.1. Impact on Vulnerable Communities

Regarding the urban poor, it is not only the unsightly nature of waste but also the potential health hazards it poses. Most slum areas in Africa suffer the indignities of passing directly alongside vast open ditches and unprotected watercourses, many being fouled with organic waste from several activities such as food vendors, provision stores, restaurants, and automotive repairers. It is not surprising to hear that diarrhoea kills more slum dwellers than an earthquake in a month. At least every two decades, West African slum dwellers face this kind of

death toll. Waste in urban Africa is a litany of problems that include corruption, lack of awareness, information and training, lack of infrastructure, lack of resources, lack of enforcement, the absence of political will, and the absolute poverty of the urban poor.

A few examples from Cameroon will illustrate this assertion. With reports that more than 70% of the 15,000 tons of waste produced daily in the country's two largest cities are left to rot, it appears this is the anthropogenic gift West African cities give to their less-endowed counterparts regarding urban development. The addressees of this African post-gift include poor sanitation, infectious diseases, and poverty. The presence of community organisations in the design, management, and implementation of waste collection is an essential tool for addressing improper waste disposal. This was a key factor behind the successful implementation of the municipal solid waste collection program in Cameroon, which increased waste pick-up services in poor areas of the city.

8.2. Gender Dimensions

The role of women and girls in domestic waste management, particularly in waste picking, has long been ignored. Most women involved are in the informal sector, making it hard for government agencies to incorporate them. These women are primarily poor, have their homes in the vicinity of the dumpsites, and have no other source of livelihood. Nonetheless, women confront substantial challenges during and after the collection of waste. For the most part, women have no viable options to convert waste into valuable items, a key area of waste management that could provide better returns for them. Their work is dangerous and unhealthy, as well as carries a social stigma. Children do not attend school to support the women, and girls may drop out altogether. In addition, children are exposed to a host of unhealthy and toxic substances that increase the toxic load on their bodies and minds. This situation reinforces a low social status further compounded by unfair pay for work done compared to men. The government is not ready to involve women in solid waste management or convert this disposition as principal support.

Nonetheless, an increasing number of women show entrepreneurial skills in making essential products from waste materials. These women can act as mentors, showing how women can be productive in this sector. The spirit of the community connected to women’s work will allow the conception of interventions that support the community's current strengths. It also insists that stockholding programs or revolving funds can create space for women to expand opportunities

by giving them access to value chains associated with waste, possibilities to improve the inventiveness in separating groups of waste streams and developing the use of valuable products from waste. Women must be involved in the development and execution of policy and budget activities – programs meant to enhance the working conditions of the population so that the informal sector policies respond to the needs of both women and men. Data on solid waste policy should be openly available; possible participants should clearly understand the processes and rules the government plans to agree upon.

9. Technological Innovations in Waste Management

Technological innovations in ICTs have played a monumental role in advancing virtually every sector of the economy, including healthcare, agriculture, education, energy, and government operations, among others. Hence, technological waste management innovations should be mobilised and invested in changes and transformations in global consumption and production patterns. Interestingly, some technological and methodological innovations are already available and ready for public and private sector use.

Mobile phones are increasingly employed for various waste management services, including electronic ticketing and route optimisation. A new application was designed to cut any middlemen out of the electronics recycling process. Where the traditional marketplace has individuals listing and selling electronics to other individuals, this application has consumers list their unwanted electronics. The program emails the seller a shipping label after filling out information regarding the electronics' condition. When the used electronics are received, the program emails the seller a gift card for the electronic devices. Other platforms use an equivalent process to exchange specific used gadgets for cash. The cash value is calculable using the online marketplace.

Other technological applications target waste management by addressing pre-treatment and processing technologies, waste reduction technologies, advanced landfill, recycling, and waste-to-energy technologies, quality control and management systems for recycled products, technologies to turn by-products into resources, integrated information technologies for waste management facilities, mobile waste management technologies, financial planning support, and policy and environmental information dissemination tools and products. It would be interesting to see how existing applications of blockchain technology could be adapted to revolutionise the waste management supply chain and its value chain.

9.1. Biodegradable Packaging Solutions

New high-tech biodegradable plastics and corn starch are used in different countries to eradicate the problem. These new plastics degrade in less than 300 days compared to conventional plastics, which take 400 years. In addition, they are made from renewable sources—corn and potatoes—compared to the unsustainable petroleum-based materials currently flooding the market. The Biodegradable products come at a price—50% higher than conventional plastics. Keeping in line with the Clean Development Mechanism for the Rio +10 talks, a research and development company is working to develop a new biodegradable plastic bottle to hold drinking water in developing countries. The bottles use potato or corn starch-based plastics, and their degradation time can be programmed from several days to several months. In rich countries, bottling companies will pick up the bottles after use and deliver them to composting centres, but bottlers in developing countries cannot afford this high-cost method.

An alternative disposal system must be implemented—commercials, restaurants, schools, and households can become composting centres to degrade the bottles. Most of the material must be degraded before disposal to prevent any issues. One possibility open to bottlers of water and cold tea in developing countries is to add value to the bottle. With advances in active and intelligent packaging technology made in recent years, bottles could be designed to absorb and release antioxidants and vitamin C into water.

9.2. Waste-to-Energy Technologies

Waste-to-energy (WtE) technologies are based on adequately handling, pre-treatment, and conditioning waste and conversion to some valid form of energy, often a combination of electricity and thermal energy. The technology is based on the following principle: the natural oxidation process of organic matter releases methane, which can be harvested and used to produce electricity and heat. However, the controlled combustion or pyrolytic conversion of the organic matter releases energy directly in the form of light, based on the principle that energy is stored in organic compounds. This method suits municipal solid waste and hazardous and biosolid waste. In addition to complementing the fossil fuel banks and energy supply chains, this technology has numerous other environmental benefits and material recycling. WtE reduces air pollution, water contamination, disease vectors, odours or greenhouse gas emissions; minimises the volume of waste disposed of at landfills and waste tipping fees; and contributes to better energy diversification. WtE plants have been reported as a cause of some

controversy. Some communities oppose new plants and objects based on speculated harmful climatic impacts during emissions, plant operation, or the plant's location.

In the greater Cameroon context, the composition of waste streams has changed due to economic, industrial, and population changes. These changes have introduced significant challenges to the waste management infrastructure. In the past 50 years, many countries that require modernising waste management infrastructure have increasingly relied on some form of waste incineration, which is efficient, its installation is affordable, and whole WtE systems have been built. The result is the preferred generation of power and thermal generation. These operated as significant waste treatment plants and were a valuable option where space was at a premium, and abundant flammable materials had no other helpful outlet. Upgrading these plants has demonstrated the need for technology development, including emissions control systems and improved energy conversion technologies that can be produced at a competitive cost.

10. Community Engagement and Participation

Consequently, the active and full engagement of the community is vital in shaping the program together through an integrated stakeholder engagement strategy, which includes the broadest possible consultation, outreach, and involvement of stakeholders. The specific objectives of the stakeholder engagement strategy concerning radioactive waste governance were to create a credible and effective dialogue between the government and the stakeholders, informed by the stakeholders' viewpoints and concerns; identify and address the concerns of local stakeholders, and decrease, as appropriate, the obstacles to dialogue and engagement; and consider that stakeholder comments and views are taken into account such that the final waste management strategy balances the needs of the local areas that ultimately host the relevant facilities, as a means of enhancing the process and promoting acceptance and sustainability of the policy. Providing an inclusive and transparent approach for the public to understand the processes of radioactive waste management is essential to prevent misperception or public distrust due to secrecy, even though significant portions of the information will not be opened to the public. For any policy to be implemented successfully, the participation of citizens, especially those directly impacted, should be taken into account and given a leading role. To meet such ambitious challenges, the stakeholders must be fully involved in project management by participating in the policy's decision-making and implementation. Individuals, including members of

the public or activists, as well as formal and informal groups and potentially affected institutions in their own right, require a stable and ongoing presence in the system that manages radioactive waste issues so that they are equipped to forge well-balanced uranium-related policies. Recognising such aspirations, the authorities' international obligations on public participation are an essential legal and organisational feature of the policy for safe and sustainable radioactive waste management. The organisation and management of public participation in national policy on radioactive waste management and project development involve the integration of entity- and facility-specific communications and public relations into the process.

11. Role of Non-Governmental Organizations and Civil Society

NGOs and international and local civil society play an essential role in raising awareness of environmental issues. As they are seen daily by the local population (rural and urban), who often share the same beliefs and practices, these civil society organisations are well placed to disseminate information and education programs on waste management and other environmental issues. In Cameroon, certain NGOs are making considerable efforts. Their actions consist of the following:

- Lobbying and sensitisation activities on waste management policies and their implementation.

- Collaboration in implementing municipal waste management services; sensitisation and mobilisation of the population by raising awareness of their role in the collective responsibilities of community life preservation.

- The implementation of projects through fundraising and technical interventions at the community level or for those interest groups. They act as service providers in hazardous waste management sectors.

12. Government Initiatives and Funding Opportunities

Several opportunities have been established by the government of Cameroon and other institutions to support the various forms of waste management. Some areas of opportunity include the Artisanal Cooperative Model, the Integrated Solid Waste Management of towns with fewer than 500,000 inhabitants, the Integrated Management of Common Garbage Collection System, and the Solid Waste Fermentation Project. Other funding opportunities include a small grant program for community action for the environment in Cameroon in the area of waste

management. Using this funding, groups have been trained and have implemented waste sorting, integration, composting, and the collection layout.

The success of this program has shown waste management as an additional source of income for local authorities and populations. In the same region, the DC defended rapid action for sustainable development of the Southern countries in the African environmental program and funded the technical equipment for waste processing in the frame of a pilot project. Creating or expanding waste management systems generates more need for investments in staff training and waste collection, transportation, or processing, with the following positive economic effects.

13. The Role of Education in Sustainable Waste Management

The management of waste in the Republic of Cameroon faces multiple challenges. One significant challenge is the scarcity of waste management professionals. The three universities in Cameroon are aware of our society's significant concerns in environmental management at national and international levels. Many hands-on problems show population pressure, especially in urban centres. They affect populations as a whole, but especially the most vulnerable people. Responding to these problems involves the information and education of all stakeholders.

The outputs depend a great deal on the inputs. We must supply waste that can be transformed into knowledge and good sense. An educational system can have several types of desired impact. It can influence knowledge, know-how, and how to be. It can also strive to facilitate behavioural change, which needs factual information about the existing problems. A particular concern for us is our appeal to decision-makers to implement long-term solutions, sometimes exceptionally leading to short-term pain in adjusting final goals despite social and economic pressure. The challenge of waste management is very demanding on personnel and resources but offers a powerful incentive to be relevant in our teaching processes or content.

14. Conclusion and Recommendations

Cameroon is said to have vast waste management programs, which, if properly run, could serve as sources of income for the government at both the local and national levels. The study results revealed that waste is now a public threat and intrusion in Cameroon, especially in the urban areas. Positive attitudes towards environmental health are poor, but the government, for its part, is making serious efforts to provide enough health facilities for the people and reduce unnecessary

expenses on the treatment of environmental diseases. In light of the current research, there is a significant need to change the attitude of waste management operatives in the country. The time to act is now if the national goals associated with waste management—reducing environmental pollution, improving the quality of life, and transforming waste into valuable activities—are to be achieved.

It should, however, be noted that environmental attitude modification usually evolves over a long period and requires considerable effort. The researchers in this study suggest that the government should embark on various pressure groups in environmental awareness campaigns. These pressure groups might include various ministries and state corporations to take the issue to the villages and towns in Cameroon. Multiple vehicles, such as schools, churches, and political parties, should be identified for effective environmental education, especially those facilitating attitude modification. A forum should involve and educate both the private and business sectors. Using pragmatic, credible, amiable, and attractive personalities could achieve all these. As suggested, the government has already embarked on this policy. Adopting a paradigm shift in the effect of waste management is expected to stimulate waste management programs to become a source of income for the country. It is equally anticipated that the shift will sensitise people to be responsible for their waste, thereby reducing waste generation and production. Individually generating less waste is just as vital and effective in its reduction and management. An environmentally friendly attitude is far better than aiding our environmental behaviour.