Texila International Journal of Public Health
ISSN: 2520-3134
DOI: 10.21522/TIJPH.2013.10.04.Art005

Managing Municipal Solid Waste Issues; Sources, Composition, Disposal, Recycling, and Volarization, Chililabombwe District, Zambia

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Abstract

Solid waste continues to pose important challenges to our environment on a daily basis. Insufficient solid waste management systems and equipment have contributed to the alteration to the ecosystems, including water, air, and soil pollution that infringes on the health of the general public that is associated with health ailments like cholera and other food and water borne diseases. Chililabombwe district's face has continued to be dented with the unkempt environment with littered solid waste that has become a stinging and widespread challenge, especially in the urban areas of the district. Solid waste (SW) collection and working disposal systems are the major problems of the urban environment in most developing countries worldwide. MSW management solutions are financially dependable for the technical viable, socially inclement, and legally accepted. Solid waste management remained the biggest challenge that all the local authorities in Zambia and many developing countries in Africa. Commercialization or valorization of organic food waste was one of the important research areas that could combat the increased solid waste in the environmental causing environmental degradation. The objective of this study was to address matters that would respond positively to the waste management crisis in the district. As waste continues to be accumulated, with its high generation, more technologies are sought in the area of treatment and exploitation of organic and municipal waste through composting and anaerobic digestion in the management of waste. The lack of technologies and machinery has equally downplayed the essence of waste management in the Chililabombwe district.

Keywords: *Anaerobic, Digestion, Landfill, Organic, Solid wastes, Valorization.*

Introduction

Many developing countries are grappling with the high generation of solid waste and its management. Chililabombwe district continued to be under pressure and stressed to manage the waste being the border town of Zambia with Congo DR. The main trend of increased generation of waste burdened on the limited resources of the local authorities, exerting pressure on the local authorities fletched budgets by foregoing other service deliveries in preference to waste management [1]. Management of solid waste comes at a huge cost, as many resources are involved in machinery acquisition, daily running services, and maintenance. Additionally, the fluctuation in the cost of fuel has also played an integral part in most local authorities meeting the most anticipated service of waste management by the residents and business houses [1]. Most of the literature reviewed that related to waste

Received: 11.05.2022 ***Accepted: 14.09.2022*** ***Published on: 29.12.2022***
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management in developing nations indicated that only a few articles supplied quantitative information but rather qualitative data. For example, it was noticed that one of the objectives of such studies were to determine actions and behaviour by stakeholders that provided solid waste management service to the communities were affected by many factors in that sector. The study was ascertained by the fact that many study cases were conducted in four (4) continents, in twenty-two (22) developing countries with more than thirty (30) urban areas, respectively. Population increase, rapid urbanization, booming economy, and the rise in the standard of living in some developing countries greatly contributed to the high generation rate of municipal solid waste generation [1].

Sources, Composition and Characterization of the Solid Waste

Municipal solid waste (MSW) continues to play a negative role and has proved to be an enemy to the environment with its effect to the health of the environment today, which could pose a health risk and challenges to our mother nature. Local municipalities; generally; were responsible for the waste management according to Environmental Management Act (No. 12 of 2011 Section 56(1). EMA (No. 12 of 2011) was the Principal Act governing and regulating environmental issues in Zambia and provides specific regulations for the discharge, collection, storage, transportation, and disposal of gaseous, liquid, and solid waste. Section 56 (1) A Local Authority shall, within its area of jurisdiction.

1. Collect and dispose of or arrange for the collection and disposal off all the household waste in accordance with this Act.
2. Ensure that waste is collected, transported, and disposed of in accordance with this Act.
3. Ensure that waste management services are provided within its jurisdiction in a manner that prioritizes the recovery, reuse or recycling of waste and provided for the treatment and safe disposal of the waste.

Its main functions include the protection of the environment and the control of pollution. It provides for the health and welfare of people, animals, plants, and the environment.

Regardless of the waste being categorized as such by its composition, little or nor much was done to enhance recycling processes with the material high in organic contents, but rather was left in the environment by posing health risks to the general public. The waste in the district was classified with its composition by material as given in Figure 1.

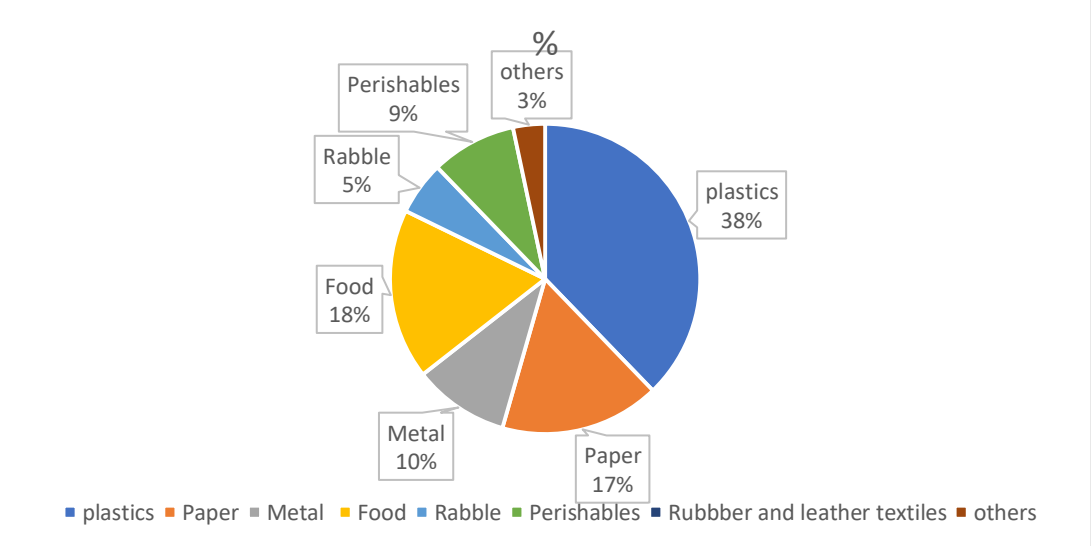

Figure. 1. Waste in the District with its Composition by Material

Source: Authors own information from field data

The waste generated came from different sources of human activities were encountered. Other studies reported that the municipal solid waste generated from most developing countries was mainly from households (51–75%), of which (28-47%) was from commercial entities, markets, and other public places. The kind of waste generated included of industrial in nature, domestic waste, and street waste, among many others. Generally, the kind of waste would be heterogeneous in nature. Thus, it normally has variable physical and chemical characteristics that depend on the original sources of generation. The composition included plastics, food, metals, rabble, rubber and leather textiles, perishables, and others.

Other studies showed that collection, storage, transportation, and final disposal of solid wastes were the major problem in urban cities and peri-urban areas. A similar situation was also noticed in some cities in East African countries that faced the same challenges relating to solid waste management. Among the issues that contributed to the vice of poor waste management was the poor economy, poor attitudes coupled with bad behaviour towards waste management. Many countries, especially developing nations, are failing to manage waste expected and in line with its mandate because it is quite costly to run waste management that requires modernized waste management equipment. Lack of capacity among the municipal waste managers and the limited resources made it even more difficult to sustain the vice, resulting in poor service delivery by the municipal councils.

Other factors noticed by other scholars were, among others, lack of sorting of waste at source, no recycling among waste generators, lack of waste storage in the business places, and more especially, waste from residential houses was uncountable for proper disposal. This resulted in indiscriminate disposal of waste in open areas, drainages, and along the streets within the township centres [1, 2].

The Socio-cultural, economic, legal, political, and environmental factors were the main issues that affected the MSW management in most developing countries, Zambia inclusive. It notably reviewed that management of solid waste at capacity required the adoption of new technology with modern mechanization to meet the uprising challenges of waste in developing countries that were somewhat influenced by social and cultural norms.

Urbanization has been another contributing factor to the high generation of waste in most cities, as the population continued to increase proportionately, so was the generation of solid waste was equally at its peak, making it difficult for management [2].

The main objective was to assess the factors leading to un-collected municipal waste in the Chililabombwe District of Zambia.

1. To determine factors that would improve solid waste management in the Chililabombwe district.
2. To determine factors that affected the proper waste management that influenced insufficient waste collection services in the district.
3. To find out whether the district practiced recycling of waste management.
4. To assess the inadequacies of waste disposal facilities in the district.
5. To evaluate whether there was lack of human resources in waste management by the council in the district.
6. To determine whether there was political influence on solid waste disposal options on solid waste management.

Research Design/Methodology

The study was descriptive in nature, whose aim was to highlight the challenges faced by the district to manage its solid waste and how it could apply other waste management mechanisms, such as recycling the waste into other goods. The approach was described as a process of collecting data in order to answer research questions concerning the current status of the subject of the study. The research design looked at issues such as recycling,

decomposition, and management of organic and inorganic waste in the district.

The study used questionnaires for data collection as the main data collection tool for its sample size, that was drawn from the main population. The study used both qualitative and quantitative data for statistical techniques for analysis and presentation of results. The study dealt with personal interviews on the views regarding waste management in the district, focus group discussions were used to discuss matters regarding waste management and the views on how best waste can be managed as a district, self-administered questionnaires enabled the researcher to interact with the participants being interviewed whereas structured questionnaires were administered to the institutions and other business houses.

The participants consented in writing to be part of the study through consent forms and were assisted by the trained research assistants to enable them to understand the concept of the research as some of the participants could not properly understand the official language and the trained research assistants were able to interpret and record the data with the full consent of the participants themselves.

Results

The results of the study revealed the actual findings on the ground regarding the waste management system in the Chililabombwe district. The results showed that many residents in the district perceived waste management as the core business of the local authority and had nothing to do with them. The results pointed more to do with behavioral change among the residents of Chililabombwe. The local authority, on the other hand, didn't operate to the full capacity due to financial and equipment constraints that was coupled with a lack of trained specialized personnel in solid waste management. It further revealed that the local authority had no recycling facility making it difficult to manage solid waste; worse still, the Chililabombwe district has got no sanitary landfill for easy waste management.

Presentation of the Results

The results were presented both in charts and Table form for easy interpretation of the findings.

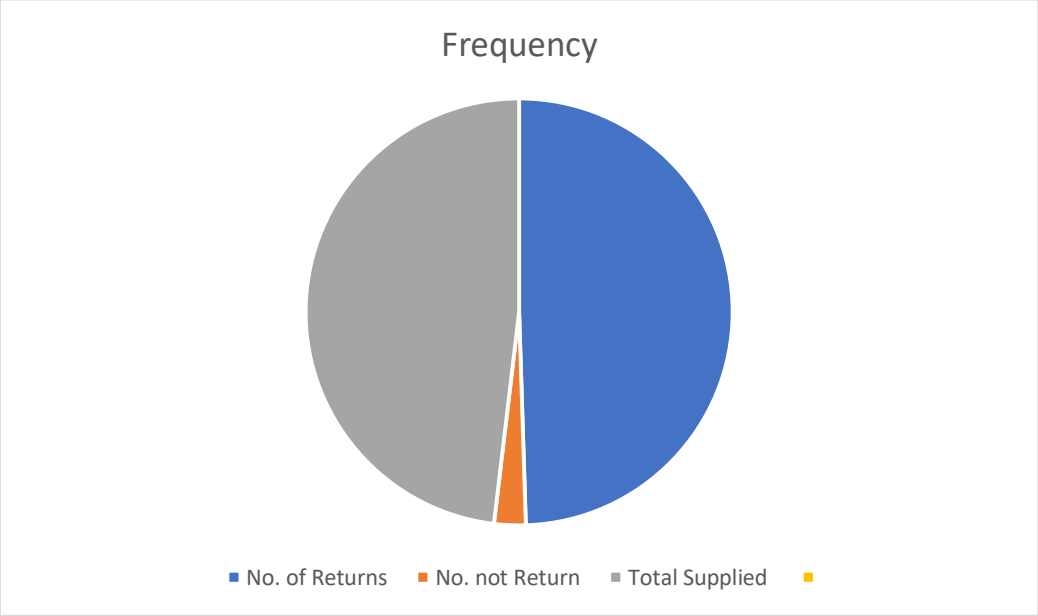

Figure 2. Frequency of Supplied Questionnaires with the Returned

Lifestyle related factors practiced on waste management

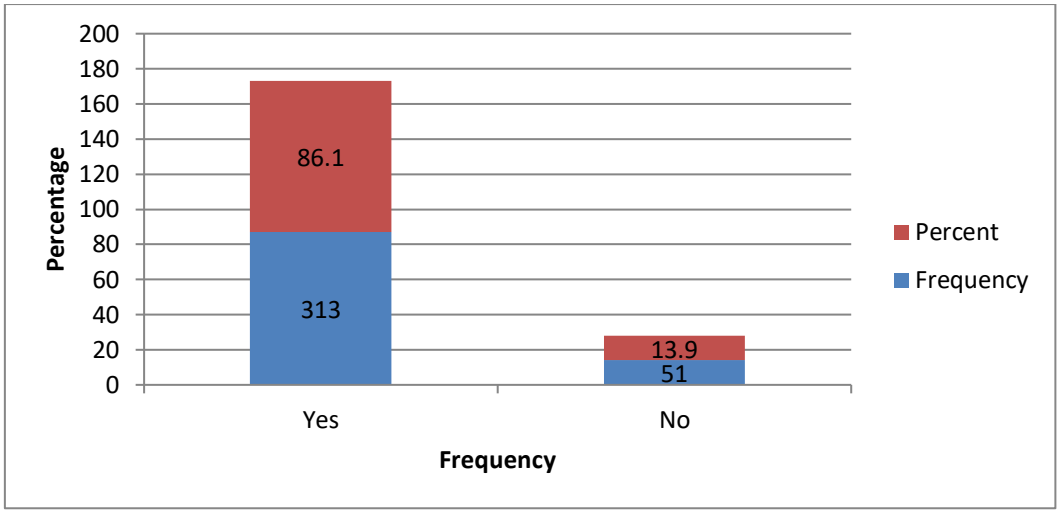

Figure 3. Knowledge Levels on Health Impact Regarding Waste Collected and Well-Managed Solid Waste

The graph represents respondents' knowledge levels of the health implications and aesthetics effects of un-collect municipal waste. A total number of 313 representing (86.1%) responded Yes, implying that they were knowledgeable, while 51, representing (13.9%) responded No, indicating that their level of understanding on solid waste management had been construed as not understanding the implication of the aforementioned as a health factor.

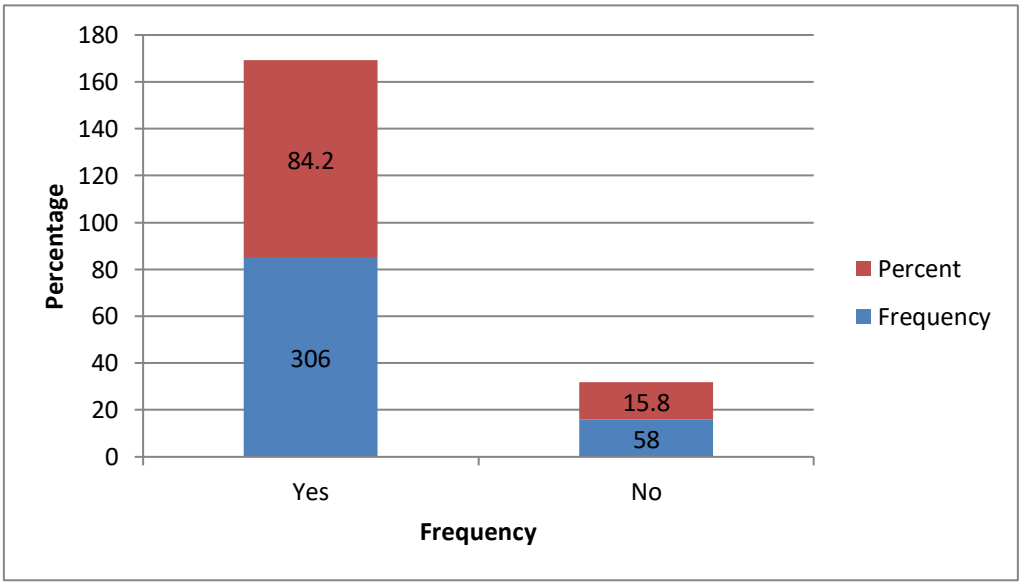

Figure 4. Attitude of the Community Members towards Waste Management

The above graph shows a summary of respondents' altitude toward a reduction of escalating levels of municipal waste. A larger representation of 306 of the respondents representing (84.2%) showed a negative altitude and linking their reasoning on the economic side than the health-associated complications while 58(15.8%) were on the positive side and demonstrated some concerns on the accumulation of solid waste in the district and its immediate impact on the environment and the people at large.

My own opinion on this figure shows that most people are fully aware of the health consequences that could be aligned with improper disposal of waste but attaches the implementation only to the local authority.

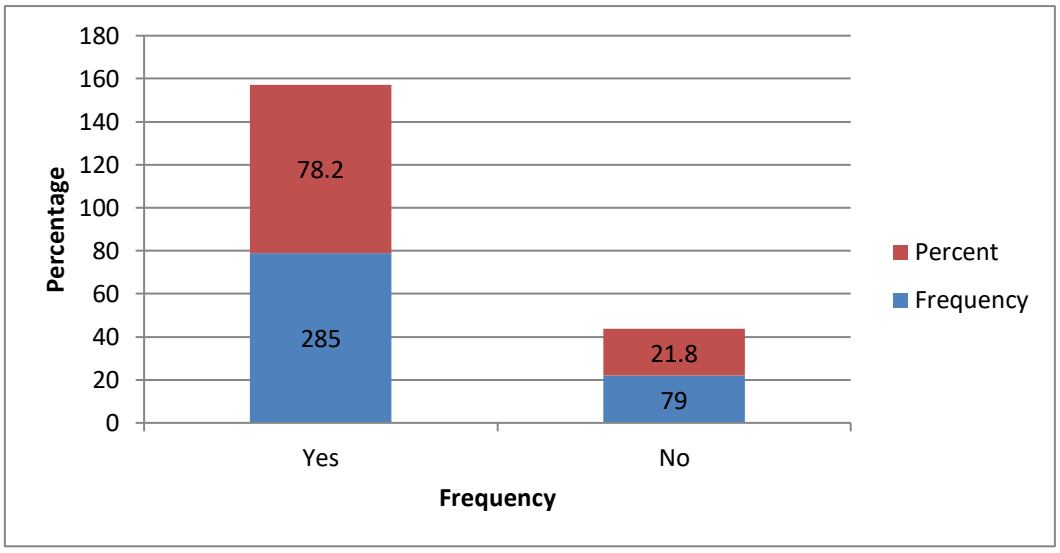

Figure 5. Understanding the Negative Health Impacts on Waste Management

The above diagram represents the impact of the native or indigenous traditional way of disposing waste on escalating municipal waste levels. The majority 78.2% (285) responded yes while the minority, 21.8% (79) responded not, respectively.

The residents understood the negative impact of indiscriminate waste disposal on both the environment and the people's health but underscored that waste management required more sensitization and health education on proper waste management.

Statistical Tests for the Hypotheses

This section presents an account of the outcomes of the statistical tests performed on the hypotheses. The data was analyzed at 95% confidence level or p = 0.05. Fisher's Exact Test for hypothesis.

Discussion of the Findings

The magnitude of the solid waste management problems in Chililabombwe district.

According to the findings of the study, the magnitude of the problem of solid waste management in the district of Chililabombwe has been deteriorating or worsening due to shortage of expertise specialized in waste management, lack of modern waste equipment, financial resources from the local authority, legal and administrative enforcement of environmental regulations and lack of community willingness to the polluter pay principle.

Together with these issues, this study established a lack of public awareness and environmental ethics that resulted in un-sustained solid waste management and disposal. This was found cutting across the district, rather than a small area or place. Due to the weakness of the law enforcers and little financial resources to undertake vigorous patrols within the district; the study and the people themselves [2, 3].

To understand well the danger of solid waste management, the study established that in the outskirts of the district centers, solid waste hardly or is never collected as it's either burnt or buried in the yards. The findings were in congruence with other studies as observed [3]. A scenario of Lusaka district where the magnitude of the solid waste was a problem also found in the outskirts of the cities, towns, urban areas, and municipalities, from which this study found that solid waste was found in outskirts of the urban areas, turning into sources of environmental contamination, indiscriminate disposal of waste by the community members.

Respondents also impinged diseases and public health threats among the people in the district were related to unsound or indiscriminate

disposal of solid waste. The study found that there was bad ordure arising from the illegal dumping sites which had mushroomed the townships of the Chililabombwe district. The indiscriminate waste attracted dogs, cats and many more street children scavenging food around the district [4].

Solid waste and un-cleared drainages in the district had been implicated in high incidences of malaria cases with high malaria attack positivity in the district. Unkempt or indiscriminate disposal of waste contributing factors associated with the incubation and proliferation of flies' mosquitoes, and rodents; in turn, transmit diseases that affect the population's health such as malaria, diarrhea, cholera, and typhoid now with the embattlement of Covid-19 and many other public health concerns [4].

Respondents' knowledge levels of the health implications and aesthetics effects of increased sold waste management indicated that 330 (86.1%) responded Yes, implying that they were knowledgeable, while 14(13.9%) responded No indicating that their level of reasoning had not beyond the aspect of understanding the implication of the aforementioned.

With the sample size of 383 respondents that represented the number of households, a total number of 364 questionnaires were returned and analyzed, representing a 95% turnout of the total of 383 questionnaires administered and 19 questionnaires were not returned, representing 5% of the total administered. The study noted that 300 were males representing 78.34% of the sample size, while 83 were female, representing 21.67% respectively. The age range of respondents indicated that 53 were in the age range between 21-30 years, representing 13.9% 99. The median range was aged between 31-34 years, amounting to 25.7% while 231 were aged 35 years and above, representing 60.4%. The largest number of the respondents were married with children representing 86.1%, with the minority being either single, divorced, and on separation, respectively.

Academic distribution of the sampled population indicated that the minority (11), representing 3% had attained tertiary education, 65(16.8%) were the median group who had reached at least primary school, 27(6.5%) had never stepped in a classroom while the majority 280(73.3%) had attained either a school certificate or General Certificate of education

Respondent's altitude towards a reduction of escalating levels of municipal waste also indicated that 306(84.2%) showed a negative altitude and linked their reasoning on the economic side of the health implications of indiscriminate waste, while a small fraction 58(15.8%) understood the direct impact of indiscriminate disposal of waste on the health of the community if not taken care of.

The impact of native or indigenous traditional ways of disposing waste on escalating levels of solid waste showed 78.2% (280) of the respondents who still argued that waste management was the duty and responsibility of the local authorities to collect and dispose of the solid waste without any condition. In comparison, 21.8% (103) responded no, implying burying or burning of waste within their yards or homes was an olden way of waste management no longer a factor, as it contributed to high levels of solid waste accumulation and the burning continued to pollute the air hence the vice was retrogressive and was a likelihood of many public health diseases. It shouldn't be encouraged anymore [5].

Disposal of Solid Waste

The study reviewed that improper bin collection practices, collection, transfer and/or transport systems had immersed effect on the characteristics management of solid wastes. Besides, the poor of planning criterion, inadequate health education and sensitization by the public on the collection schedules, number of vehicles for solid waste collection and poor road network, and insufficient infrastructure were among the other factors that contributed to poor management of solid waste in the district.

Effective ways and affordable waste collection services were noted and reported in the study conducted by researchers indicated thereof [5].

The essence was to organize the informal sector to part in the management of waste through the promotion of micro-business enterprises within the operation areas. It was noticed lack of knowledge and expertise on waste treatment by authorities was one of the important factors that affected the handling of solid waste in the country and the district at large. [5] The results indicated that the supply of waste facilities significantly affected the available choices for waste disposal, hence dominated with indiscriminate disposal.

Further, insufficient waste storage and distance to transport the waste from the disposal sites in the district were reported to be among the factors that necessitated indiscriminate disposal and illegal dumping in the drainages, along the roadsides, and many other open places. who mentioned that insufficient financial resources, absence of legislation, well equipped and engineered landfills all contribute to the limitation of solid waste safe disposal [6].

Disposal of Municipal Solid Waste

Likewise, solid waste disposal has proved to be one of the major environmental problems in the collection, management, and disposal of the MSW in the Chililabombwe district. Lack of innovation and modern mechanization of municipal solid waste management systems led to a significant environmental disintegration marred with public health threats ranging from water pollution, air pollution, and soil pollution. Such environmental problems are associated with human health disorders due to the increase in greenhouse gas emissions and other toxic substances [6, 7].

The amounts, quality, and significance of such disposal are poorly understood. It was generally assumed that the household-generated waste was small. Thus, risks of disposal were negligible, yet it was the opposite of the reality on the ground. Nevertheless, industrial waste, municipal solid waste, and many other types of waste continued to raise toxic and hazardous products in the environment and posed many health risks with some of the elements that were lethal to the general public. There are some concerns about the presence of several chemicals in household products. [7] The consequences and the impact to the environment resulting from the disposal of HHW were also of great concern that required remedies. Thus, the disposal of household waste at the dumpsite should be in tandem with the existing pieces of legislation on waste management (EMA) so as to decrease the risk to the environment.

Globally, about 65% of MSW's were disposed of in landfills or dumpsite areas. MSW contains mostly, hazardous substances included, including batteries, paints, mercury-containing waste, pharmaceuticals, vehicle maintenance products, and many other products. Further, it was noticed that much of the waste disposed of, more than 53% of the landfilled waste, consisted of hardboard paper, construction waste, household waste, papers, and food that are biodegradable by the anaerobic bacteria and plastic wastes in general.

Problems of Solid Waste Disposal Within Rural and Urban Communities in Chililabombwe District

The indiscriminate disposal of garbage (solid wastes) was noticed to be a widespread problem in both urban and rural areas in the district. Similarly, main open places and drains were widely used in dumping varieties of garbage, was a source kind of domestic organic and inorganic waste. The inconsistences in the manner that waste was collected created room for indiscriminate disposal by the residents as the collection system were not well coordinated. This resulted in blockages of the drainage system with the dumping of various waste articles from the residential houses and main other public places. [6] Much of this waste was plastic and paper with few toxic materials, and

those with toxic materials had a hazard impact on the environment due to the breakdown of the degradable constituents, a matter that added significant loads of BOD and the immediate impact to the eco-system.

In fact, lack of financial incentives to stop them from such practice and to encourage them to alter the habits contributed to the escalation of the general public outcry on uncollected and poorly managed solid waste in the districts. Most of the residents in the district opted to dump waste in the drains, burning in the yards as a way of getting of the waste, yet it was a serious disaster for the surrounding communities and to the country. Meanwhile, the existing laws were not effectively enforced to prevent the environment from such hazardous practices unless a better solution could be achieved if we overcome the situation [7, 8].

Management and Recycling of Solid Waste

The district lacked recycling companies that could have reduced on the waste that was taken to the dumpsite, and this contributed to indiscriminate disposal of waste as it never had any value of some kind. The pricing for solid waste disposal and high disposal pricing had a positive effect on recovering the generated solid waste. [8] noted that social influences, regulatory and altruistic were among other factors that, if well tapped, could strong pillars in the communities to inculcate recycling habits in most areas to keep our environment clean, green, and healthy [8].

In other cases, it was noticed that distance to the set bins was yet another barrier and others used it as an excuse to dump waste anyhow and anywhere. [9] added that in order to increase the recycling rates, the local government must encourage the markets for recycled materials and should increase the number of professionals in the recycling companies.

Further, other factors noticed by the scholars included financial support for different recycling projects to support the infrastructure of the recycling companies in the country [10].

Suffice to say the importance of recycling. Chililabombwe district has no recycling companies making it difficult to recover some of the products that could have been recycled. Indeed, solid waste managed remained a big challenge in main countries worldwide as collection and disposal required financial resources that included modern waste equipment with highly qualified expertise. [11], [12] Proper waste management in developing countries needs commitment and consistency, financial sustainability, technique feasibility, and socially and then legally acceptable for the environmentally friendly way of dealing with waste issues [13].

In the same way, a good knowledge of the characterization of solid waste before disposal was important for the management of solid waste. In the course of the management of solid wastes, some problems could be arisen due to their possible heterogeneous structure by nature. The physical features of solid wastes were extremely important for the mode of collection, transportation, recoverable matter, and energy transformation, as well as for selecting and designing the proper disposal methods.

Some studies suggested that residents near waste dumping places risked the health of the general populace, especially the children that experienced low weight birth, congenital anomalies, and some suspected cancer cases [14]. However, waste was not only considered as a source of materials recovery (metals, glass, plastics, and fibres) and energy, but also as oil saving and a tool for environmental protection.

Valorisation of Solid Waste in Chililabombwe

The increasingly tighter regulations in terms of organic solid waste, as well as increasing the demand for renewable chemicals and fuels, are recently pushing the industrial manufacturers and the environmentalists towards sustainability to improve cost-effectiveness and meet

customers' demands. During the past few years, valorization of organic food waste has seen to be on a high rise of scientific research to ascertain its chemical composition to the environment.

It has attracted more attention as a potential alternative to the conventional solid waste disposal of a wide range of residues in landfill sites [15-17]. In addition, the increasing development of environmental strategies to process such solid waste was an interesting area of increased importance in our current society.

The study shown that municipal authorities in the study areas lacked the necessary financial resources to organise waste management effectively [18]. The limited funding to the waste sector makes it difficult for the department of public health to acquire proper solid waste equipment to respond effectively to the high generation of waste in the district. Also, it hampers the recruitment of enough workers to undertake regular cleaning of the roads and public places. [19-21] The poor waste-handling attitude of people also emerged as one of the causes of the poor waste situation in the study areas.

Sometimes there is what seems to be the inability of municipal authorities to enforce existing by-laws on waste disposal resulting in a general failure to respect the law and a 'throw-it-where-you-like' attitude towards waste disposal among the population [22-24].

The inadequate and inconsistency data on the waste situation was also a constraining factor in waste management in the district. It emerged from the interviews conducted with staff of the municipal waste department that no research study has been conducted to generate accurate data on the quantities of waste generated, the types and characteristics or even the waste disposal needs of the population [25-27].

The improper disposal of solid waste in Chililabombwe district continues to pose a health risk to the general population. Whilst the validity of this statistic cannot be ascertained, one thing that is clear to any casual observer was that quantities of solid waste remain uncollected each day and waste accumulation was a growing problem in the district, making the city environments health hazardous and life threatening. [28-34] equally important, the study found that dumping done everywhere by the community regardless of the municipal council undertaking punitive actions on members of the society that were found dumping indiscriminately, and loads of solid waste collected by the municipal waste departments are dumped in a poorly managed dumpsite managed by a private entity as, the local authority does not have a landfill for proper disposal of solid waste, which create dire environmental conditions in the vicinities[35, 36].

Conclusion and Recommendations

From the study it could be concluded that there are more gaps in the improvement of solid waste management in Chililabombwe, as it has been noted the main challenges faced by the local authority ranging from lack of modernized waste management equipment, financial constraints in waste management, lack of specialized trained waste managers and the unwillingness of the community members to cooperate with the local authority. On a contrary, it was noticed that there was no political interference in management of waste in the district. The local authority however, needed to continuously engage the residents through community mobilization campaigns with the civic leaders and other stakeholders for sensitization on the importance proper waste management. The district is however, needed to engage franchised waste companies that could supplement on the works the local authority was doing that could create more employment opportunities among the youths of Chililabombwe. The practices, storage, and disposal of solid waste in the district were unsatisfactory together with the separation of waste that was not practiced was yet another setback in the management of solid waste. However, the intolerance by the communities

and the unwillingness to participate in the proper way of waste management was still a concern that worried the authorities and its impact to the district. Therefore, there was a need for authorities to engage residents of urban areas, slums, and other peri-urban areas to improve the practices in solid waste management, especially on waste separation and disposal in the district.

Recommendations

The study covered a small part of a big challenge that surrounded the management of solid waste in Chililabombwe. However, this article opens quite a few opportunities for further research studies, and the listing was abridged below for future waste management.

1. Stakeholders and other government institutions to come on board to partner with the local authority in the management of solid waste.
2. The local authority to engage the community with the civic leaders and ward development committees to sensitize the community on the proper disposal and management of waste.
3. The local authority to engage the central government for funding in the solid waste management sector.
4. The local authority should procure modernized waste management equipment and employ qualified waste management experts.
5. The local authority to engage franchised companies in waste management and other stakeholders in the recycling of the waste into other goods.

Acknowledgement

The author wishes to express deep appreciation and gratitude to Chililabombwe Municipal Council and the People of Chililabombwe district under the study "managing municipal solid waste issues; Sources, Composition, disposal, recycling and volarization, Chililabombwe district, Zambia."

Conflict of Interests

The author has no competing interests to declare.

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