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MUNICIPALITY SOLID WASTE (MSW) MANAGEMENT CHALLENGES OF CHINHOYI TOWN IN ZIMBABWE: OPPORTUNITIES OF WASTE REDUCTION AND RECYCLING

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ABSTRACT

Domestic and industrial solid waste poses a serious challenge to municipalities and countries, as waste now competes with humans for land and financial resources to make it safe. The research examines solid waste management in the Town of Chinhoyi, Zimbabwe. Using a survey method and utilizing questionnaires and observation check lists, the research assesses the challenges of the town in waste management and recommends ways of reducing and recycling biodegradable solid waste. The research reveals that Municipality Solid Waste (MSW) generated amounts to 2.7kg per household per day, of which 47% is biodegradable. Waste management is constrained by a lack of financial and material resources resulting in a failure to properly assist residents in waste storage, failure to collect and transport the waste, resulting in residents and business resorting to illegal dumping, burning, composting, and burying the waste at the generation site. An effective recycling of the bio-degradable components into compost and production of energy is recommended.

Keywords: Municipality Solid Waste (MSW); Waste management; Reduction and Recycling; Bio-degradable

INTRODUCTION

Municipal solid waste (MSW) management constitutes as one of the most crucial service provision challenges facing African towns and cities (Achankeng, 2003). Due to the economic melt down experienced in Zimbabwe during the ten years, between 2000 and 2010, many challenges militated against sound urban solid waste management. These challenges included the inability of municipalities to supply safe water to residents, inability to dispose of, sewage and the breakdown of infrastructure and service delivery in MSW management activities from waste generation, storing, collection, and safe disposal. The cholera outbreak of 2008-2009, which claimed over 3,500 human lives in Zimbabwe, was a direct consequence of a breakdown of municipality services, including irregular refuse collection, among other factors (Federation of Red Cross & Red Crescent, 2010). MSW management involves five stages. They include waste generation, storage, collection, transportation, and disposal. This research sought to establish the extent of the breakdown of solid waste management system in Chinhoyi Town. It establishes the challenges faced throughout the MSW management activities.

Solid waste management across the globe now focuses on waste reduction and recycling before disposal. The study highlights the challenges in waste disposal by the municipality and makes recommendations on waste reduction and recycling opportunities for composting and energy generation as a consequence of the availability of bio-stock.

PURPOSE OF THE STUDY

The objectives of the study were to assess MSW generation and disposal by households and businesses in Chinhoyi; assess conformity of Chinhoyi municipality to the laid down procedure as specified in the Environment Management Act and their own waste management policy; establish challenges faced by all stakeholders in the MSW management and recommends sustainable MSW reduction and recycling activities based on rudimental activities being done by residents and business.

THE STUDY AREA

Chinhoyi town is the provincial capital of Mashonaland West Province in Zimbabwe. The town is approximately 120 kilometers from Harare along the main road to Kariba. The town is situated in a farming area. The population of Chinhoyi, according to the 2002 national census, was 56,794 (Central Statistical Office, 2002) The town has four (4) low density residential suburbs (Mzari, Golf Course, Mapako, and Orange Groove) and nine (9) high density residential suburbs (Cold Stream, Brundish, Hunyani, Mpata, Gadzema, White City, Ruvimbo, and Chikonohono).

The town has two universities, Chinhoyi University of Technology and Zimbabwe Open University and has the biggest referral hospital in the province. The town has two hotels, Orange Groove Motel and Chinhoyi University Hotel. There a three major supermarkets with one of them having two branches. The town has a major opaque beer brewing company, a parastal abattoir (the Cold Storage Commission), which used to service the European Union market with beef. There is also a cotton ginnery and several small industrial companies, with one of them being an auto brakes servicing company, which could produce toxic wastes with asbestos.

METHODOLOGY

The research was carried out to ascertain Chinhoyi town solid waste management. The study employed the survey research method. The study used two types of questionnaires as data collection tools, targeting households in both high and low density residential suburbs, businesses, and the municipality. The questionnaire for the residents was completed as an interview, while the one for businesses was self-completed. The questionnaire was used to establish household solid waste management practices, quantities of waste generated, and challenges faced with solid waste disposal. The households were chosen randomly through a random picking of stand numbers.

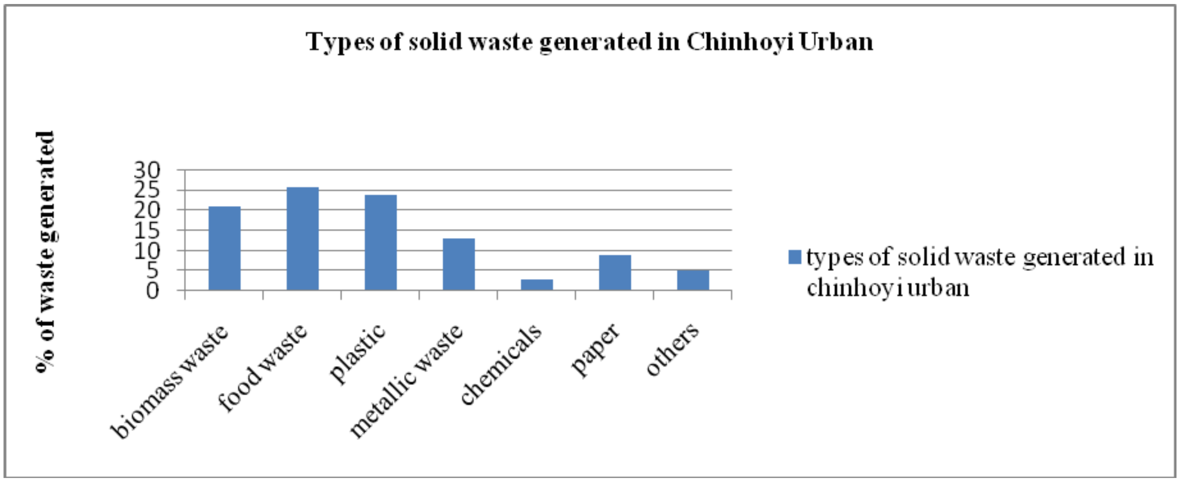
The study also used interviews based on a check list for the municipality. Field observations of dumpsite and residential illegal dumping spots were also done. The field observations were based on a check list and an interview of dumpsite attendants. Data was then summarized into tables for analysis and presentation using spread sheet software.

RESULTS

Waste generation

The results from 250 households interviewed showed that there was a high amount of biodegradable waste (47.1%) made up of biomass waste (which included hedge cuttings, tree and shrubs pruning, and weeds) and food waste generated in Chinhoyi urban. Plastics (24%) also constituted a high percentage of waste generated. The amounts of biodegradable waste generated in Chinhoyi Town compared with other towns and countries. In the European Union the average biodegradable waste generated from households was 40% (Wullt, 2010). In the Kenyan Capital, Nairobi, Muniafu and Otiato (2007) reported a biodegradable component of 40% of the total MSW. In Chirundu border post, the biodegradable levels were 72%, while in Marondera, the Intermediate Technology Consultants (1998) reported 43% of MSW being biodegradable.

Figure 1: Types and percentages of solid waste generated in Chinhoyi town



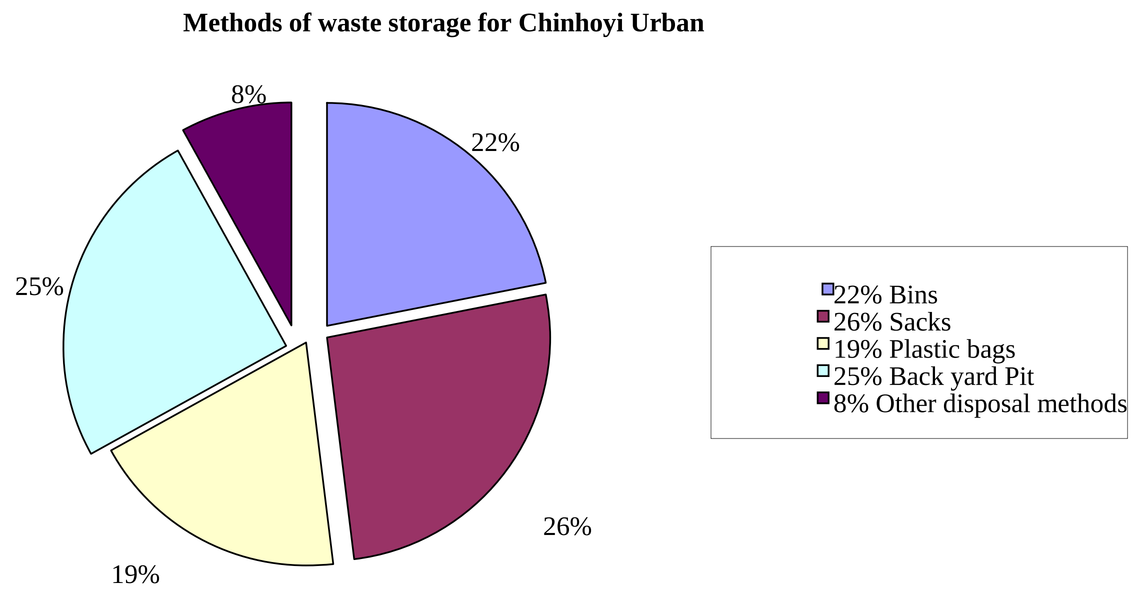
The results also revealed that each household generated an average of 2.7 kilograms per day, which was translated to 985.5kg per year, per household. Results from the survey showed that there were, on average, 8 people per household in Chinhoyi town, with a population of 56,000. This was translated into 7,000 households in the town. The residents of the town generated, on average, 6,895 tons of MSW per year, of which 47% is bio-degradable (3,240 tons). The amount generated per household, per day was about three times the 0.8kg level of the Sakubva suburb with a population of 62,419 in Mutare (about 5,600 more people in Sakubva than Chinhoyi Town), which was reported by Manyanhaire, Sigauke, and Munasirei,(2009). The figures for Sakubva high density suburb appeared very low, compared to Chinhoyi town, due to the fact that the Sakubva study was done when the country was experiencing severe food and commodities shortages due to the economic meltdown.

The major waste generated by businesses surveyed, which included retail supermarkets, hotels and restaurants included plastic bags and boxes, food waste from catering services, food spoilage from failure of cold storage facilities due to electricity power outages, and butchery food waste. However, the quantities generated by the businesses could not be quantified. Indications showed that the amounts could be as much as that which was generated by households.

Storage of MSW at Household level

The storage of wastes generated by households before collection and transportation to the dump site involved the use of various receptacles. These receptacles included polythene bags, propylene sacks, metal bins, and disposing waste into pits dug at the back of the house. The results show that 22% of households were using bins, which used to be provided by the municipal, 26% were using sacks, 19% were using plastic bags, 25% were disposing of waste into pits, and 8% were using other alternative receptacles, such as boxes and plastic buckets (*Figure 2*).

Figure 2: Waste Collection Receptacles



Storage at Business and Industrial Level

Of the businesses and industries interviewed, management highlighted wastes generated by these businesses that were stored in plastic containers and cages awaiting collection by the municipality. Wastes, such as paper, were usually stored separately and are collected by a waste paper recycling company.

Collection and Disposal of MSW by Municipality

According to the municipality management, the collection of MSW falls under the responsibility of the Environmental Health Department. The collection of MSW in residential areas should be done once every week, while in the Central Business District and other public places it should be done every day, according to the Municipality’s Policy on the frequency of refuse collection (*Table 1*).

Table 1: MSW solid waste collection frequency policy

Sector	Policy on frequency of refuse collection
Household	Once a week
Industrial sites	Once a week
City centre	Daily
Market place	Daily
Hotels	Daily
Hospital	Once a week
Schools	Once a week
Colleges	Once a week

The Chinhoyi survey indicated the following results: twenty six percent (26%) of the respondents indicated that the Municipal Council does not collect wastes from their homesteads; 48% indicated that collection of wastes were done at least once a week while those in the town center, market place, and hotels indicated that collection is done twice a week. The remainder (18%) of the respondents indicated that collection was rather erratic and inconsistent. In businesses and industries wastes were supposed to be collected daily by the municipality, but because of the resource constraints, the collection is erratic.

Table 2: Frequency of waste collection in residential areas

Collection times	% of respondents
Not at all	26
Once a week	48
Twice a week	8
Erratic	18

The council was failing to provide the re-usable plastic bags to residents for MSW storage at the generation site. The municipality was not regularly collecting waste from residents as per their policy. This service was, however, being provided for the agriculture produce markets and businesses (*Table 2*).

Waste Handling Practices by Households

In the past, the municipality provided re-usable plastic bags for MSW storage at the waste generation sites and metal bins for businesses, including the farmers produce market in Gadzema high density suburb. The municipality of Chinhoyi was failing to provide this valuable asset to households and they were failing to regularly collect solid wastes from households as per their policy.

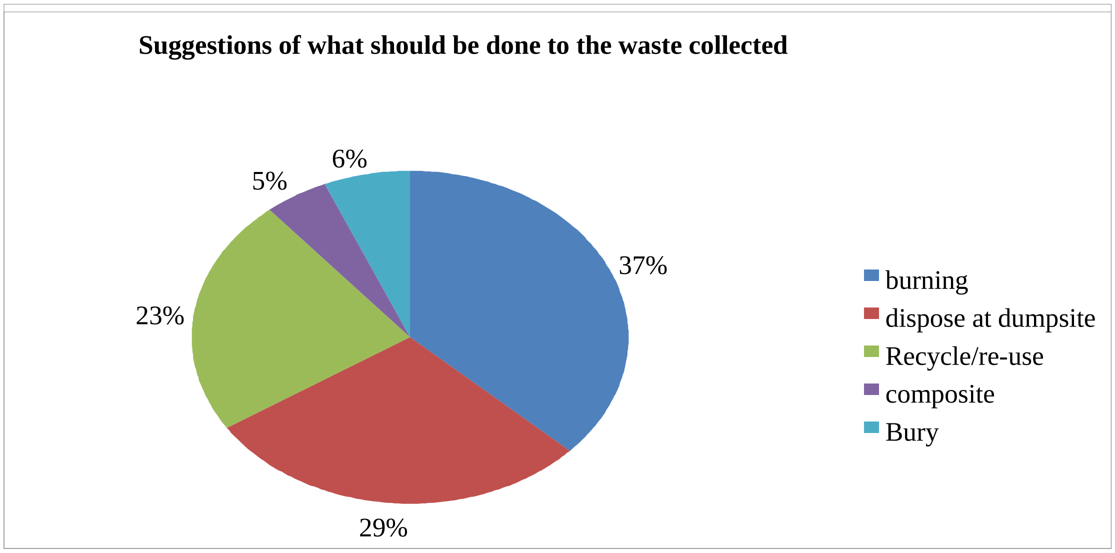
Table 3: Waste Handling Practices at Household Level

Practice	**%**
Burning	31.5
Burying/open pit	31.9
Illegal dumping	30.1
Compositing	6.5
Total	*100*

As a result, households were using other methods to dispose their household waste, which included; burning, dumping in open pits and/or burying at home; illegally dumping in the street corners or storm drains and compositing (*Table 3*); and activities that pose hazards to the environment and increase the health risk of the residents. Fumes from burning wastes caused acute respiratory infections and the odors of the fumes made the residential environment uninhabitable. Open waste dumps are prime breeding sites for houseflies, rodents, mosquitoes, and other vectors of communicable diseases, such as fever, dysentery, diarrhea, cholera and malaria.

Only 6.5% of the households seemed to reduce and recycle their wastes through composting. Due to the challenges of infrequent collection of wastes and lack of waste storage receptacles, various waste management strategies can be employed. Households suggested strategies such as burning, composting, and recycling of wastes, among other methods (Figure 3). Due to financial resources constraints, the municipality does not have specialized human resources for refuse management.

Figure 3: Household Suggestion for Waste Reduction at Generation Site



Waste Handling Practices by Businesses

Retail supermarkets and butcheries tried to re-use some of the meat and meat products that became unsuitable for human consumption by producing it as pet food for sale. It was sold to crocodile farms for consumption by the crocodiles and some was donated by the Society for the Prevention of Cruelty to Animals (SPCA).

Stale bread and confectionary products were usually crushed before disposal to prevent solid waste scavengers, who collected and sold it to unsuspecting clients. One retail outlet indicated that they burnt their waste using diesel fuel in some disused mine shaft. Some have dug open pits within their premises to dispose their waste due to failure by the municipality to regularly collect the waste as per their policy. Observations on some of the pits revealed that they are not fenced off to prevent scavengers; the pits take time to fill up before covering with soil. This implied that vermin and disease carrying vectors could multiply uncontrolled.

Waste Collection and Disposal at the Dumpsite by Council

The municipality used three vehicles (an open 7-ton truck and two tractor drawn trailers) to collect and dispose the MSW. The waste, at times, was blown away by wind from the open truck and tractor trailers, resulting in pollution of the environment. Upon arrival to the dumpsite, scavengers mobbed the vehicles and were observed jumping and clinging precariously onto the truck and tractor trailers before they off-load their cargo. All waste collected was disposed of at the municipality dumpsite.

The municipality used the open dumpsite type of waste disposal. The dumpsite was located about three (3) kilometers out of the town. The choice of the dumpsite was prompted by its proximity to the town and settlements and not as a measure for land reclamation through land filling. The site also took into account the prevailing wind, (north easterly). In view of the town expansion in the direction of the dumpsite, the city council intended to relocate the dump site to a landfill. The council had no special procedures laid for disposal of all industrial wastes, whether toxic or not. The most common wastes received from the industry were scrap metals and manure.

Challenges Faced in Disposal of Waste by the Municipality

Waste disposal is now a logistic and costly issue, globally (Vencatasawny, Ohman and Brannstrom., 2000), not just for developing countries. The council has two subcontractors for the collection and transportation of MSW from the town, including the use of one vehicle from the municipality. In Chinhoyi, the collected waste was disposed at the municipality open dump site. The open dump site method involved compacting waste before burning it, under constraints imposed by the Environmental Management Agency of Zimbabwe.

The site was located 3 kilometers from the built up area and was not fenced off. Flies and other disease vectors were observed at the dump site. Houseflies, which are effective carriers of sanitation-related pathogens for diseases, such as cholera and diarrhea, are capable of flying up to 5 kilometers (Prickford, 1983). The nearest residential area is therefore susceptible to these vector borne diseases.

The dumpsite construction was not done according to stipulated regulations. It was not compacted, and was without lining at the base. Leachates were forming ponds at the dump site. Further tests need to be carried out to determine the effect of the leachate on underground water sources, as the land slopes towards an approaching settlement.

The study observed that wastes at the site comprised plastics, paper, glass, metals, used oil debris, asbestos car brake linings, medical waste, and pop cans. There was no segregation of waste done prior to or during the waste disposal. The mixture of waste poses health hazards to scavengers who are active at the site. Some mothers were seen feeding their babies at the site.

The Chinhoyi dumpsite was characterized by indiscriminate fires and several leachate ponds. The dumpsite attendant reported that the waste remained uncovered for more than 5 months due to lack of equipment. Such a condition promoteds the breeding of disease vectors, such as houseflies. The leachate from the dumpsite could pollute the underground water, which is an important alternative water source for the residents situated close to the dumpsite.

Conformity to Waste Handling by Laws

Health Hazards Identified in Waste Disposal

Residents were reported to be resorting to burning of solid domestic wastes. A visit to the dump site also revealed that due to the activities of people scavenging for re-usable waste, there were fires on site. The dangers posed by the fires include the destruction of biodiversity, air pollution, and emission of ozone depleting gases, such as carbon monoxide, nitrogen dioxide, and sulfur dioxide. These gases also posed a threat to the human health. The country has laws, such as the *Statutory Instrument no. 7 of 2007,* which criminalized the lighting of fires, failure to put out fires on one's property, and failure to put in place adequate fire prevention measures on one's property.

The Environmental Management Agency is empowered to enforce regulations and court rulings concerning a lack of control of fires within residential areas and dumpsites. However the Environmental Management Act provides for the issuance of orders to the Council, to ensure that the municipality does not contribute to the damage of the environment due to intermittent fires at the dump site under its jurisdiction.

Opportunities for Solid Waste Reduction and Recycling

A visit at the Chinhoyi MSW disposal site indicated that the site will soon be abandoned in search of a new site, due to the unavailability of space to continue dumping the waste.

Composting of Bio-Degradable Domestic Waste

The vegetable component of domestic waste varies from city to city and country to country. Manyanhaire, Sigauke and Munasirei (2009) cited 15.62% for low income cities of India, while for Chirundu, Zambia food waste accounted for 72%. Muniafu and Otiato (2010) in Kenya found 75% of the waste to be compostable waste. The suburb of Sakubva in Mutare had

32% (Manyanhaire, Sigauke and Munasirei, 2009). The Intermediate Technology Consultants (1998) observed a range of 15-28% (Chimhowu, 1998) to 43% in Marondera, a town similar to Chinhoyi in terms of size and population.

Recycling of bio-degradable domestic waste into nutrient stable compost can result in both reduction of waste and reduction in water pollution through substitution of chemical fertilizers by compost in urban agriculture. In a case study of urban agriculture farmers in Harare, Kisner (2008) recommended that the current farming practices of using chemical fertilizers, were leading to underground water pollution through eutrophication and leaching. The composting of MSW and availing of such compost to urban agriculture farmers could assist in pollution mitigation.

As the bio-degradable component of domestic constitutes 47.1% of waste generated, the composting of this component, if done at the household level, will result in corresponding reduction of solid waste generated by households needing disposal by municipalities. Supriyadi, Kriwoken and Birley (2000) also advocated for source separations and large-scale composting as a means to deal with the solid waste problem.

Studies in Israel indicated that the waste sector may contribute as much as 25% of green house gas emissions over 20 years (Ayalon, Avnimelech and Shecter, 2002). Ayalon, Avnimelech and Shecter (2002) further stated that mitigating options showed that the most cost effective means to treat the biodegradable organic component is by use of aerobic composting.

The use of vermiculture (earthworm farming) technology to recycle bio-degradable solid waste is also an option worth evaluating and pursuing. Chinhoyi town is surrounded by dams with high fishing activities. The town is located on the Harare-Kariba highway. There are numerous entrepreneurs selling fishing worms (earthworms) along this highway. Training in earthworm farming technology using bio-degradable domestic wastes can be a way of waste reduction and recycling while, at the same time, creating employment opportunities.

PRODUCTION OF ENERGY

Waste to Energy Conversion Options

The over 3000 tons of bio-degradable MSW generated by residents and potentially more from businesses offer a large quantity of bio-stock for energy production. Energy recovery from MSW offers one way to reduce and recycle wastes. Thorough tests have to be conducted to determine the actual physical and chemical characteristics of the waste (Johri & Rajeshwari, 2008). The conversion of bio-degradable MSW to energy can be done in three possible ways: thermo-chemical; biochemical; and physicochemical processes.

The thermo-chemical conversion process can be characterized by higher temperatures and conversion rates. The process is best suited for lower moisture feedstock and is generally less selective for products. Thermo-chemical methods, such as pyrolysis (Hoffman & Fitz, 1968), biomass gasification (Jain, 1981), and incineration (Banwari & Reddy, 2008) require infrastructure set up. These processes resulted in production of heat that can be used to generate steam that drives a turbine for electric power generation. Biomass gasification produces combustible gases, which can be further cleaned and utilized to run water pumps at the municipality water works, saving on electricity expenses.

Biochemical MSW processes (Fulford, 1998) used a bio-digester to anaerobically digest and ferment organic biodegradable wastes with high moisture content. Anaerobic digestion can be used to recover both nutrients and energy contained in organic waste products. The process generated gases with high methane content (55-70%), as well as bio-fertilizers. The gas produced was purified before feeding into internal combustion engines or gas turbines to generate heat and power. Chinhoyi town is a farming community. The production of bio-fertilizers can be an opportunity for farmers to access this alternative source of crop nutrients.

MSW of high lignocellulosic biomass can be converted to bio-ethanol by a series of biochemical reactions using specialized micro-organisms (Kadam, Forrest & Jacobson, 2000). A micro-ethanol plant, which blends ethanol with petrol, was feasible and can positively impact Zimbabwe’s fuel needs as a 100% importer of fuel. This can lead to a reduction of Chinhoyi town carbon footprint.

The physicochemical technology, such as co-processing (Pandey, 2008), can also be utilized. This is a process of using the cement-manufacturing process to recycle, reuse, or treat wastes, while simultaneously manufacturing cement in a single combined operation. The waste required to be used as fuel at the cement kiln is evaluated for its physical, chemical, and thermodynamic properties to ascertain its energy value and compatibility with the cement-making process (Pandey, 2008). The co-processing method is one ideal method for recycling wastes by recovering their energy value. Much of the waste burned as fuel and recycled in cement-making contains high energy contents.

Johri and Rajeshwari (2008) report of an Indian company that developed an indigenous technology for the conversion of MSW into a Refuse Derived Fuel (RDF). The RDF can cost-effectively replace domestic fuels, such as firewood and kerosene, and has been claimed to be a good substitute for coal in production processes in the local industries. If Chinhoyi municipality was to espouse such a technology, it will, in a way, generate some form of revenue and, at the same time, help in mitigating the green house gas (GHG) emissions.

Potential Impact of Waste to Energy Conversion Technologies

Technologies are available that can recover the thermal energy contained in the trash, thus replacing limited fossil fuels, such as coal, oil, or natural gas, used by conventional power plants, there by contributing to the reduction of CO_2 emissions. The technologies can efficiently harness the untapped energy potential of organic waste by converting the biodegradable fraction of the wastes into high calorific value gases, like methane, through bio-methanation processes. The digested portions of the wastes are highly rich in nutrients and are widely used as bio-fertilizer in many parts of the world (Fulford, 1998). The waste converted to energy would otherwise be sent to landfill sites, hence reducing the dependence on land filling and on fossil fuels.

Oliveira and Rosa, (2000) proved that communities that employ waste to energy technologies have higher recycling rates than communities that do not utilize waste to energy. Today, various methods of treatment of MSW have been successfully developed and implemented, globally. Scientists have achieved new technologies by which human beings will not only restrict their knowledge for disposing of wastes, but also develop some alternate products generated from the same wastes, which can be highly useful to society (Banwari & Reddy, 2008).

Conclusions

The Zimbabwe National Waste Management Strategy objectives include the following: to ensure involvement and participation of all stakeholders in waste management; to develop waste management enterprises among Central Business Organizations and Industries; to develop a sound technical National Waste Management Strategy for the collection, transportation, treatment, and final disposal of all types of waste in Zimbabwe, with the aim to improve and safeguard public health and welfare; and to further promote resource recovery and environmental protection, among other objectives.

The municipality of Chinhoyi town is failing to collect refuse from high density residential suburbs. Access to municipality services should not be dictated by the area or suburb where one resides. All poor people have the right to live in a clean and healthy environment that is not harmful to their health as stated by the Environmental Management Act (EMA) (2007).

This study revealed that in Chinhoyi town, there was poor management of wastes in all five aspects of waste management, ranging from the storage, collection, transportation to the disposal of waste. This is evidenced by the accumulating wastes and illegal dumps that were observed. Residents are increasingly made vulnerable to diseases, such as cholera and diarrhea. Although different sectors of the society have tried to solve the problem through various initiatives, such as clean up campaigns, the piecemeal approach does not manage to address the endemic waste management problem.

Resource challenges for small towns, such as Chinhoyi, with high unemployed residents, offers opportunities to create volunteer refuse cleaners and waste sorters to periodically clean up residential areas, which has been done, with success, in Cape Town, South Africa (Miraftab, 2004). For waste management to be effective there has to be activities to reduce and recycle it so as to reduce environmental pollution and prevent health hazards. MSW is an important raw material for sustainable energy and bio-fertilizer production.

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