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EXAMINING WASTE-TO-RESOURCES POTENTIAL FROM MUNICIPAL SOLID WASTE: EVIDENCE FROM PANTANG DUMPSITE IN ACCRA, GHANA

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Abstract

This study examined the potential of generating resources from Municipal Solid Waste (MSW) from the Pantang dumpsite in the Accra Metropolis, Ghana. Exploratory design was employed and convenience sampling method used to collect primary data from two waste operators at the dumpsite using face-to-face interview technique. The results revealed that landfill method is the common practice to waste management, with no regards to sustainable waste management techniques such as household sorting, compositing, recycling and incineration. The findings showed that majority of the MSW are made of organic substances followed by plastics and paper materials which could be processed further to generate methane for energy, fertilizer from the agricultural practices and potential recycling of plastic and metallic cans for reuse in local industries. Thus lack of sustainable waste management practices may increase global warming, affect human health and increase over dependence on virgin resources which in turn not consistent with the pillars of sustainable development. The study recommends that Accra Metropolitan Assembly (AMA) improves civic education, collaborate with research institutions and engage households towards sustainable waste management best practices.

Keywords: Sustainable waste management, waste-to-resource, zero waste, integrated waste management, millennium development goals

INTRODUCTION

Since the beginning of industrialization, global economies have over relied on virgin natural resources for socio-economic development. However, with the increase in urbanization and population, sustaining resources across all sectors of various economies has become an important aspect of socio-political discords. Remarkably, with the increase of population and its related challenges, waste generation tends to be an unavoidable aspect of human lifestyle. Uriarte (2008) argued that waste involves products of human, animal and economic engagements which have been considered as unusable.

While the Millennium Development Goal (MDG) 1 prescribed the need to eradicate extreme poverty and hunger, the MDG 7 recommended all countries to ensure environmental sustainability (UNDP, 2005). However, reports indicate that increase in economic outputs or development leads to increase in generation of waste (UNEP-ISWA, 2015). Even though Ghana has shown tremendous performance in reducing extreme poverty, it continues to experience huge challenges in ensuring environmental sustainability especially in the area of MSW management and sanitation (UNDP, 2016). Municipal waste includes waste from households and domestic-type, market waste, bio waste, separately collected bulky waste, glass, paper and road-sweeping waste (UNEP, 2013). According to Bentil and Agyeman (2014), the Accra Metropolis generates approximately 2000 tons of waste every day. Across Accra Metropolis, landfill method is a conventional approach of waste management practices. In a study, Boadi and Kuitunen (2003) confirmed that waste management practices in the Accra metropolis are not delivered in a sustainable manner. Advancing on this, Thompson (2010) argued that increased population has led to high generation of municipal waste which surpasses the country's ability to contain and process it. In this regard, this study aimed at exploring the possibility of employing sustainable waste management practices such as composting, recycling, and incineration to generate resources for reuse in other economic activities, while reducing excessive use on virgin resources.

Purpose of the Study

The purpose of this study was to examine the potential of generating valuable resource (wealth) from municipal solid waste (MSW) toward reducing MSW and virgin resources. The study specifically aimed at assessing various potential waste-to-resources such as energy, recyclable products, compost, etc. from MSW within the Accra Metropolitan Assembly (AMA).The study also delved into the various sustainable waste management practices available within the metropolis that is geared towards an efficient use of waste within an eco-friendly environment.

THEORETICAL FRAMEWORK

The theoretical framework of this study is based on the proposition of sustainable development which hinges on the premise that meeting the current needs and activities of societies should not compromise the needs of the future generation (UNWCED, 1987). Thus, ensuring sustainable development practices require the need to focus on economic, social and environmental aspects as an integral part of societal endeavor. Thus, municipal solid waste (MSW) management practices should not just focus on the disposal of the waste but also the need to efficiently and effectively transform them to resources for reuse toward environmental, social and economic sustainability. In this regard, sustainable waste management focuses on the efficient use of resources by ensuring that the amount of waste generated is significantly reduced through active application of technologies and practices that contribute to the environmental, social and economic purposes of sustainable development (Listercorp Ltd, 2016).

Municipal solid waste (MSW) is defined as a mixed collection of waste generated in urban areas which may differ in quantity, quality and in nature from one place to another as a result of the living standards and cultural setting of the people (UNEP, 2013).Globally, waste generation is projected at about 7-10 billion tons per year while MSW is estimated at a 2 billion annually (UNEP-ISWA, 2015). However, the rate of generating MSW varies widely within and between countries. These variations in waste generation depend on income levels, socio-cultural patterns and climatic factors. Advancing on this, UNEP-ISWA (2015) reported that there is a strong positive association between economic growth and waste generation with the median high-income countries being about six-fold greater than in low- income countries.

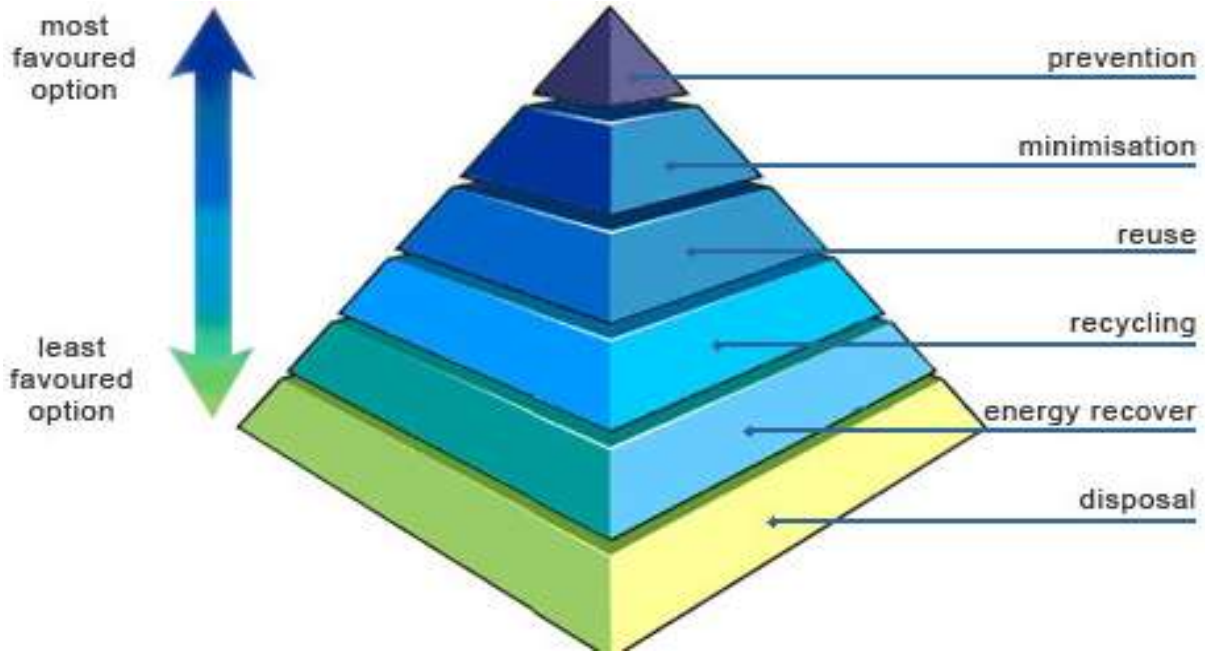
Sustainable Waste Management and Waste-to-Resource

Waste-to-resource method involves the recovery of useful resources from waste material instead of disposing it as useless material. Waste-to-resource is an integral part of sustainable waste management practices which focuses on efficient removal of selective materials from municipal solid waste through technologies including composting, recycling, energy generations, etc. for economic reuse toward reducing over reliance on virgin resources whiles minimizing both waste disposal to the best possible (Umwelt, 2013; UNEP, 2013).

Typically, sustainable waste management involves many methodologies such as zero waste (ZW), integrated solid waste management (IWM), waste management hierarchy (WMH) and resource recovery (RR). Zero waste approach incorporates economically efficient,eco-friendly, and ethical methods to ensure complete usage of resources through use-and-waste-reuse approach. Thus, applying zero waste practices underscore the need to eliminate waste by

means of reducing the use of resources while changing human lifestyle or behavior toward relying on refurbishing and reusing of resources. However, the WMHmethod incorporate zero waste principles in its practices, its implementation is fundamentally grounded on local or/ and regional economic profile, environmental and social settings (Zero Waste SA, 2012). Figure 1 shows a typical model of sustainable waste management system used in Sweden.

Figure 1: A Typical Model of Sustainable Waste Management Practices in Sweden



Source: Green Earth Citizens (2012)

However, IWM aimed at solving waste problem by considering the whole life of the product (potential waste material) and the whole waste management system including waste prevention and resource recovery to arrive at a solution that is socially, economically, and environmentally suitable for a particular area. Integrated waste management is conceptualized on the premise that all aspects of a waste management system (both technical and non-technical) are interrelated and therefore need to be analyzed together since the developments in one aspect frequently affect practices or activities in another area" (UNEP, 2005).

Waste-to-Resource Practices

MSW Compositing

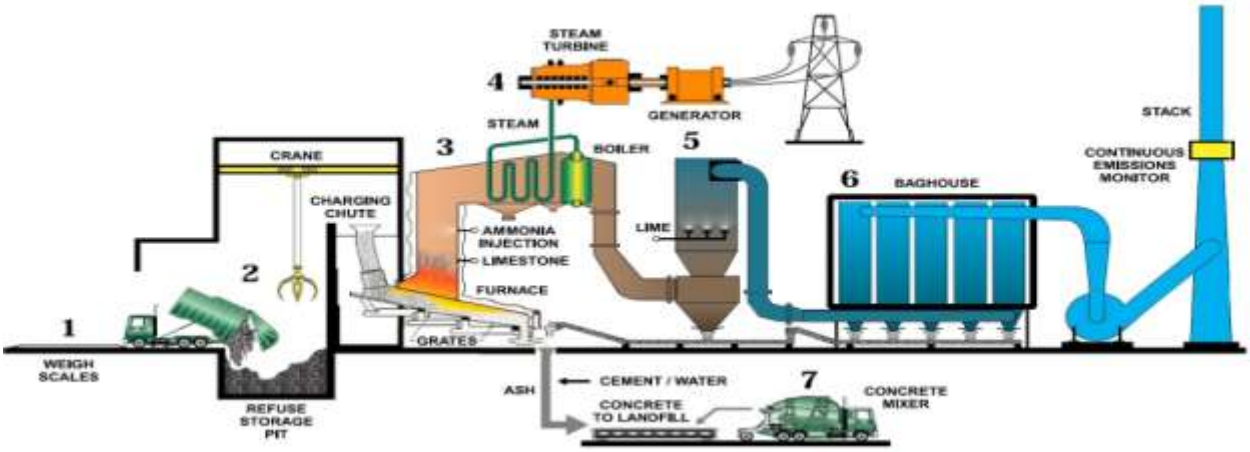
Composting of MSW involves breaking of organic waste or substances into water, heat, carbon dioxide, and compost using microorganism under aerobic conditions (UNEP 2009; US-EPA, 2008). Usually, composting outputs reduced waste and safe to the environment whiles the

composts are used as manure or processed further to produce fertilizer as agriculture inputs; the biogas generated can be further processed to methane fuel for domestic cooking and heating; and the biowaste is processed further as animal feedstock (World waste systems, 2012; Environment Canada, 2013; Zerbock, 2003).

Generating Energy from MSW

Globally, the demand for energy continues to increase due to increase in population, urbanization and increase in socio-economic activities. Conventionally, the use of incinerators to process and manage waste predominately focus on recovering heat(resource) from the MSW while importantly reducing greenhouse gasses (GHGs) (Garthe & Kowal, 2006).

Figure 2: A Typical Process flow of an Incinerator



Source: Radadi (2014)

As shown in Figure 2, heat generated from incineration process is transformed into electricity which is powered into homes for domestic heating and cooking. Advanced incinerators significantly reduce waste by nearly 90% and therefore produce relatively small amount of eco-friendly residues which can be used for other socio-economic infrastructural development such as roads or industrial construction.

Resource Recovery through Recycling

Sustainable waste management requires the need to reuse resource to minimize the over dependent on virgin resources to avoid compromising with the needs of future generations. As global population increases, demand for resource also increases: Reports indicate that in 1950, global plastic consumption was estimated at 5million tons. However, in 2009, plastic

consumption across the globe had increased tremendously to 100 million tons (UNEP, 2009).This exponential increase in plastic consumption suggested that there is substantial pressure on plastics and hence virgin resources. In this regard, recycling of MSW is a recovery of resource which involves the collection of selected scraps materials such as aluminum cans, plastics, bottles, papers and cardboards for reuse (MartinFrost, 2013).

Waste landfill and it consequences

In many advanced economies, land filling practice is considered as critically not safe for the environment as it introduces both biodegradable and harmful substances into the eco-system: During rainfall, the harmful substances in the MSW leached into the water bodies. However, the biodegradable substances in the MSW particularly generate methane. In a report, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (FMENCNS) (2006) showed that methane has about 21times effect of increasing global warming compared with carbon dioxide. This suggests that the used of landfill method of managing MSW increases greenhouse effect and hence global warming.

Empirical evidence of Zero Waste Practices: Swedish Sustainable Waste Management System

Across the globe, Sweden is considered as the benchmark for sustainable waste management. Over the years, Sweden's waste administration has evolved positively toward zero waste: while only 38% of its household wastes were recycled in 1975, however 2015 record showed that over 99% of all wastes from households are recycled in some way: Thus, about 50% of its waste is recycled while 49% of the waste is burned to generate energy (Haugen,2013). This suggests that approximately 1% of their household waste is actually considered discarded for landfill purpose (Bernabe, Sep 8, 2014). Swedish success toward zero waste is fundamentally driven by the culture of willingness and cooperation from all stakeholders (household, state agencies and administrations, corporate institutions, etc.) in its waste management sector toward sustainable waste management practices: it is mandatory for households to separate recyclable wastes into special containers to aid recycling and other recovery processes with the support from waste management institutions. In addition, in many situations, residential areas are not more than 300 metres away from recycle points (Sverige, 2016). The country's waste-to-energy practices has led to generating approximately 20% of the energy required for its district heating whiles providing electricity to approximately 250,000 Swedish homes (Swedish Energy Agency, 2015; Matthews, 2013; Sverige, 2016).

METHODOLOGY

Research Design

The approach to this study is exploratory. The design is suitable because the study aimed at examining insight of generating potential resources from the MSW instead of using them for landfill purposes. According to Uys and Basson (1991), exploratory descriptive study is usually employed in a field study to examine and advance fresh thoughts, knowledge and hypotheses for forward-looking studies after all relevant problems have been observed or studied. Advancing on this, Brink and Wood (1998) were of the view that exploratory study focus on the relevant aspects of the subject matter to reach at the applicable account of the realism of the prevailing condition.

Study Population

Across Accra Metropolitan Assembly (AMA), MSW are collected and dumped at major landfills or dumpsites including Oblogo, Ashaiman-Presby, Abokobi, Kwashiebu, Kokroko and Mallam (Annepu & Themelis, 2013). However, there are other several unauthorized emerging dumpsites across the AMA.

Sample Size, Sampling Technique and Instruments Used

Though, in qualitative study, interview may range from one to even hundreds of interviewees, single interview is sufficient to inquire into the possibility of establishing something(Baker & Edwards (n.d.); Becker, 2007).Therefore, in this study, a sample size of two MSW operators who worked at the Pantang dumpsite were interviewed. Primary data on waste management practices was collected using convenience sampling technique. Convenience sampling was employed for the purpose of proximity and easy access to data *(*Zikmund*,* 2000).The Observation method of data collection was also employed and photos of the dumpsite taken for presentation, discussion and analysis. However, secondary data on the composition of MSW within the Accra Metropolis were collected from Accra Metropolitan Assembly (AMA)(Keelson, 2013; Annepu & Themelis 2013).

Data Analysis

Data collected from operatives of the dumpsite was recorded in a dairy and contextual analysis was developed for discussion. Descriptive statistics were used to analyze secondary data on the composition of AMA MSW. Contextual analyses were also done using observations from the dumpsite.

EMPIRICAL FINDINGS OF WASTE MANAGEMENT PRACTICES AT THE PANTANG MSW DUMPSITE AND THE POTENTIAL WASTE –TO-RESOURCES FROM THE MSW

Activities at the Pantang dumpsite (landfill)

From the observation as shown in Figure 3, the Pantang MSW dumpsite or landfill is composed of various household solid wastes which include plastics, cans, solid metals, PET bottles, etc.

Figure 3: Pantang Dumpsite

Source: Authors' photo from the dumpsite

However, Scavengers explained further that they received other household solid waste such as wooden chairs, scraps furniture and gallons which are normally dumped by door-to-door scavengers or waste operators from neighboring residence. The findings showed that individual household solid waste are not separated before they were dumped at the Pantang landfill. On the contrary, sustainable waste management best practices in circular economies, such as Sweden and Germany, it is mandatory that MSW are separated into special containers before they are sent to the waste depots to aid recycling and recovery processes while reducing costs of waste management practices (Sverige, 2016). In this regard, separating MSW at the dumpsite instead of individual homes is not consistent with the best practices in sustainable waste management practices.

Table 1: Price of Scrap Metals at the Pantang Dumpsite

Price of scrap cans and metallic materials from the Pantang Dumpsite (in kg)	In GH ₵	In USD
1	0.3	0.08
1000	300	75.95
2000	600	151.90
3000	900	227.85

Source: Field Work, 2016; August 28, 2015 exchange rate wasGH ₵3.95 per USD

At the Pantang dumpsite, there were two scraps dealers: scavengers who searched through the heaped landfill, to separate or select specific scraps for sales and middlemen who buy from these scavengers and then sell them to metal processing companies or exporters. In an interview with a scrap metal scavenger at the Pantang dumpsite, he explained that his customers (middlemen) usually order for scrap cans, tins and other metallic and transport them to companies in Tema, the industrial hub of Ghana, for further processes. Further interaction revealed they earned GH₵0.30 per kg of waste metals (thus 1 ton for GH₵300 or about US$76 equivalent) as shown in Table 1. Advancing on this, it was discovered that typically he used about two months to separate about 2-3 tons of scrap metal from the dumpsite, generating an income between GH₵600 and GH₵900 (US$151.90 and US$227.85). In another interview, it came to light that compared with the scraps cans and metal trade which has unit prices, scraps cardboard has no specific unit price. However, the trade depends on the bargaining power of both sellers and buyers. Advancing on this, it was revealed that a sack of scrap cardboard ranges from GH₵0.5 to GH₵3.00 (US$0.13- GH₵1.27) depending on the quality of the cardboard.

However, the researchers observed that these operators separated cans, tins and metal containers from the dumpsite without the necessary using personal protective equipment as shown in Figure 5. In an interaction with the waste operators, they explained that it is expensive to use personal protective equipment (PPE) on daily basis and therefore they were economically forced to work without appropriate PPE. The researchers observed some part of the dumpsite being burnt with huge smoke covering the environments and the neighboring residential areas as shown in Figure 5.

Figure 4: Aluminum cans Separation Method used as Pantang Dumpsite

Source: Authors' photo from the dumpsite

Nevertheless, these operators probably out of ignorance did not show any concern of the health consequences of inhaling the smoke and not wearing the appropriate PPE. The practice of burning MSW at a centralized waste site has adverse effect on the environment as it generates significant pollutants such as Carbon Monoxide (CO), Sulfur Dioxide (SO2), Particulate Matter (PM), Nitrogen Oxides (NOx) and Hydrocarbons (HC) which have the tendency to destroy human health.

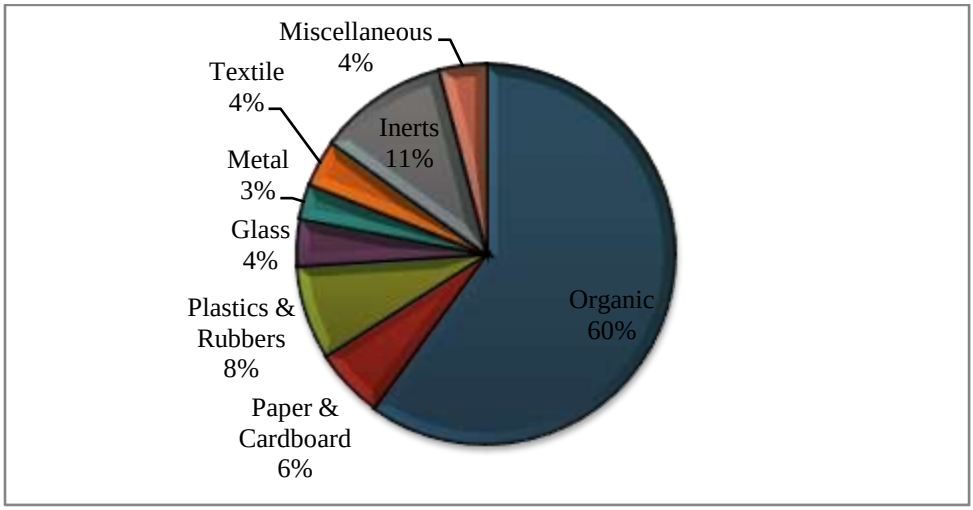
Figure 5: Open Burning Practices at the Pantang Dumpsite

Source: Authors' photo from the dumpsite

Composting of MSW at Pantang

From Figure 6, majority (60.0%) of the MSW is organic products which are usually household waste food.

Figure 6: MSW Mixed in Accra Metropolis



Source: Adapted from Keelson (2013) and Annepu and Themelis (2013)

Therefore, instead of engaging in land filling and opening burning the MSW, composting practices could be considered. Composting of MSW involves breaking of organic waste or

substances into water, heat, carbon dioxide, and compost using microorganism under aerobic conditions. Typically, compositing methods of waste management are safe and helps in reducing excessive MSW as observed at the Pantang dumpsite. The output, compost could be used as manure or processed further to produce fertilizer to enrich agriculture land in the areas toward improving national food security and reducing poverty. In this regard, the use of landfill practices such as a sole method of managing MSW is not consistent with sustainable waste practices. The methane generated from the process is tapped to generate energy for household heating and cooking

Recycling Potential at Pantang dumpsite

Today's socio-economic activities demands various plastics needs such as shopping bags, PET bottle, packaging, and for use as components in electronic products and other appliances. In this regard, global consumption of plastics has increased by 20times to 100million in 2009 from 1950 (UNEP, 2009).Figure 6 show that plastics and rubber constitute approximately 8.0% of MSW at the Pantang dumpsite.

Figure 7: Separated Plastics and Aluminum Can from the Pantang Dumpsite

Source: Authors' photo from the dumpsite

Therefore, instead of burning plastic waste to release toxic and cancerous substances into the environment which in effect destroys the eco-system and human health as shown in Figure 5, plastics from MSW can be separated and recycled. Similarly, 3.0% of the MSW was made of metals which mostly include waste aluminum cans. The demand for aluminum is expected to grow from 37million tons in 2016 to 70million tons in 2020 (Ecomena, 2016). This implies that there is enormous pressure on bauxite, the raw material for the manufacturing of aluminum. However, recycling aluminum cans requires only about 5.0% of the energy required to process bauxite to produce new aluminum (Ecomena, 2015; The Aluminum Association, 2016). In this regard, recycling of plastics and aluminum cans help reduce the pressure on virgin resources, energy usage and improved environment, while creating jobs towards economic prosperity and hence without compromising to the needs of future generations.

Potential Waste-to-Energy from Pantang dumpsite

Figure 6shows the composition of the MSW within Accra Metropolitan Assembly. According to Figure6,majority (60%) of the MSW in Accra are made of organic materials. Therefore, when this organic MSW are dumped at the open site, it passes through anaerobic digestion which emits hydrocarbons such as methane, a greenhouse gas (GHG) which contributes significantly to global warming. According to UNEP (2005), methane has approximately 21times the effect of carbon dioxide to global warming. Additionally, once these organic wastes passed through anaerobic digestion, organic compounds are formed with inorganic wastes including heavy metal such as Lead (Pb), Chromium (Cr), Cadmium (Cd) and Nickel (Ni). As a result, these hazardous substances are leached into ground, marine and surface water bodies destroying human health, microorganism extinction, and the ecosystem. However, the organic waste could be separated and the methane generated through scientific and sustainable waste processes are used for household heating and cooking or to generate electricity for the community to reduce the overburden energy deficits experienced by the Ghanaian communities. Also, the by-product, ashes could be used for concrete formation in the construction industry.

CONCLUSIONS

Though in circular economies, waste materials are considered as an opportunity to regenerate valuable resources for economic reuse, in the developing countries it is currently seen as a threat to health and sanitation and hence a significant economic costs. The findings have shown that though the dumpsite received huge amount of MSW, landfill method is the only practice used to manage the MSW in the municipality with no regards to sorting, recycling, composting, etc. This study revealed that majority of MSW is made of organic substances followed by plastic

materials which provide opportunity for further processing to generate valuable resources such as methane as energy source, compost as manure and fertilizer to boost local agricultural practices while plastics and other metallic cans wastes could be recycled to feed for reuse in the local industries.

The findings shows that lack of robust sustainable waste management practices in the municipality has the tendency to increase poor waste management practices in the municipality, increases overlying of virgin materials, increases future emission of GHGs and hence affect overall well-being and sustainability of the society. Ensuring sustainable MSW management practices can serve as a triple-edge sword: a paradigm shift that improves sanitation situation in the country while reducing excessive use of virgin and natural resources, and improving economic efficiency and prosperity. In this regard, future studies are required to investigate into the economic, social and environmental feasibility of transforming these MSW at the Pantang dumpsite into productive resources toward sustainable socio-economic development.

RECOMMENDATIONS

The researchers recommend two core infrastructures: the hard infrastructure and soft infrastructure:

- Promoting positive attitude towards household waste management practices: the municipal assemble should encourage waste sorting as an integral part of domestic waste management practices. This would reduce the complex processing of waste at the industrial level and hence reduce costs associated with waste management in the municipality. However, this requires strict legislative system and support from the local and central government to help enforce these practices toward robust waste management administration best practices.
- Improving civic education of sustainable waste practices: Changing individual attitude requires extensive education from the government and the municipal authorities. Therefore, local authorities should cooperate with state-owned agencies such as Ghana New Agency (GNA), Ghana Broadcasting Corporation (GBC), and National Commission for Civic Education (NCCE) to provide specific education on sustainable waste management practices and its impact on the municipality.
- Motivate individuals and households by reducing the price of waste collection: In a situation where costs of disposing are very high, households and individuals are compelled to dispose household waste indiscriminately. Therefore, it is important that government put in place economically affordable prices for disposing waste.

- Improve waste management best practices of sorting from individual homes and improve timely collection of waste by the appropriate agents in the municipality. Delay in the collection of waste leads to indiscriminate disposal of household wastes.
- Government should collaborate with research institutions to improve waste management technologies which fit our local content. Collaborating and strengthening academia and research institutions would help the municipality and the country to develop technologies which are based on local needs, and at affordable prices that would reduce capital costs of engaging in commercial waste management processing.
- Provide incentive to investors with the technical know-how in the waste-to-resources technologies and best practices to help utilize waste in the Ghanaian community and hence provide the necessary inputs for other industries to improve socio-economic activities in the country.

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