African Journal of Environmental and Waste Management ISSN: 2375-1266 Vol. 2 (1), pp. 113-121, January, 2014.
Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Waste to wealth potentials of municipal solid waste: A case study of Ga-East Municipal Assembly, Ghana

[1]Abiti Benedicta and [1]*Pishva Davar

[1]*Graduate School of Asia Pacific Studies, Ritsumeikan Asia Pacific University (APU), Oita, Japan

Accepted 27 December, 2013

The purpose of this research was to investigate waste management practices in developed countries and come up with a set of practical recommendations on how to improve the waste management process of the Ga East Municipal Assembly (GEMA) of the Greater Accra region of Ghana. After exploratory investigation of how waste management is being sustainably practiced by some advanced nations, pertinent data were collected from administrative personnel and operatives of the "Abloradgei" dumpsite of GEMA using interview and observation. The result shows that 48.8% of the municipal solid waste is organic materials while the remaining 51.2% are inorganic materials such as plastics, metals, paper, glass, clothing and debris. The investigation further revealed that 63% of the collected municipal solid wastes are not sorted at their sources, that municipality depends solely on conventional land filling and there exists no modern treatment or resource recovery system in the municipality. In order to improve the alarming situation, the paper focused on ascertaining resources which could be recovered from the municipality waste, socio-economic benefits of waste-to-resource to the municipality and practical ways of achieving such benefits using lessons learned from developed countries.

Key words: Waste, by-product, zero waste, reduce, reuse, recycle, circular economy.

INTRODUCTION

The term "waste" in this generation raises an issue that is worth considering. Although waste in general refers to a substance that is not desired and intended or required to be thrown, circular economy considers it as a misplaced resource. It is therefore more accurate to refer to it as "by-product" instead of "waste". This idea follows the principle of the "zero waste" natural ecosystem, where a waste of one trophic level becomes a resource to another level, thus ensuring a closed loop system which enables the movement of material through the system without waste.

The production of waste is an inevitable aspect of human existence, especially with increase in population and its associated problems. Its accumulation has begun since 10,000 BC when humans abandoned nomadic life and started living in communities. Versilind et al. (2002) described waste as a consequence of everyday life of all creatures. Everybody is responsible for the generation of waste. Every sector of the national economy – farms, mines, factories, businesses, institutions and households – contributes to the mounting mass of unwanted materials requiring disposal (Nadakavukaren, 2006).

Today, many nations face a looming waste management crisis as their landfills reach their capacity limits and begin to degrade the environment (Kallman, 2008). After effects of poor waste management is manifested in the environment, distressed health of the people living around and have lead to a negative impact on the economy. Therefore, good environment, health and some aspects of economy depend on the quality of waste management that is, how sustainable the waste is generated, collected, transported and disposed-off or recycled in an area. This has lead into effective and efficient waste management becoming an important part of socio-political policies across the globe.

Uriarte (2008) identified five stages of prevention, reduction, recycling, treatment and disposal quite important for effective waste management. Some developed countries are noted for their efficient waste management approaches and a number of them have become pioneers in effectively implementing each stage. For example, Germany, Japan, US and some European Union member states, consider waste as a material from

*Corresponding author. E-mail: dpishva@apu.ac.jp
Tel. 81-977-78-1261

which valuable resources can be extracted. However, many developing nations, including Ghana, are still straggling with the waste management issues. There are three well-developed ways to process solid wastes: landfill, composting and incineration. Up until the 20th century, household garbage was mainly treated through landfills or composting. But now, high-tech incineration plants which no longer spew billowing black smoke are in service, making garbage incineration an environmental friendly exercise.

Land filling is the least preferred waste management method as many nations have reached their landfills capacity and face a looming waste management crisis due to continued degradation of the environment (Kallman, 2008). Conventional land filling has been considered unsafe, as it contains both harmful and biodegradable substances that can leach into water bodies. Across EU, the use of land filling as a method of managing waste has come to stringent scientific scrutiny and has led to radical reduction of the practice across European Union member states. Germany has experienced a radical and steady reduction of land filling as a result of the introduction and enforcement of "landfill ban for untreated municipal waste" since 30 June, 2005 while increasing other municipal waste management methods such as recycling, mechanical-biological treatment and incineration which are considered eco-friendly and economically efficient and effective for the conversion of waste to useful resources (Eurostat, 2011).

Composting involves the use of microorganism to break organic matter (waste) into carbon dioxide, water, heat and compost (EPA, 2009). According to UNEP JP (2013), composting is a biological decomposition of biodegradable solid waste through a controlled aerobic process, conditions necessary to produce a stable and nuisance-free outputs or products which are safe for use by the society. Composting method enhances waste reductions (Zerbock, 2003) whiles its outputs are best used as agricultural inputs such as manure or further process as fertilizer (World Waste Systems, 2012). During anaerobic digesting process, biogas may be captured and further refined to obtain fuel (methane gas) which can be used for domestic heating and cooking (Environment Canada, 2013). However, the volume of this biogas depends on the composition of the biowaste used as feedstock (Environment Canada, 2013). Waste incinerations promote resource optimisation and the use of incinerators as a method of managing waste has significantly contributed to reduction of greenhouse gases (GHGs) from municipal waste. In the incineration process, the generated heat can be converted into electricity or used for district heating. Furthermore, the use of high-tech incinerators can reduce waste by about 90% and make disposal of the residue or slag from the incineration plant economically attractive or even transform them into substitute materials for grit and gravels to be used in industrial construction and road development (Young, 2010).

Research Issues

The paper attempts to answer the following three questions:

1. What factors make waste management approaches of developed countries effective and efficient?
2. What are the issues surrounding solid waste management in GEMA and what recoverable resources its municipal waste contain?
3. What practical approaches are possible in order to improve waste management situation in GEMA?

Research Goal

The first goal of the paper is to highlight effective and efficient waste management practices of some pioneer countries, which is done by means of an exploratory-descriptive case study on their approaches and common strategies. The second goal is to show waste management issues that are being faced in GEMA, Ghana; and ascertain resources which could be recovered from the municipality waste, for the purpose of which pertinent data were collected and analyzed in detail. The third goal is to emphasize the importance of sustainable waste management system and propose a set of practical approaches on how to improve waste management situation in a developing nation like Ghana based on common practices that are being adopted by developed nations.

Significance

The significance of this paper lies in the fact that it collectively investigates effective and efficient waste management practices of some developed nations, aggressively and boldly examines waste management problems of GEMA, Ghana; which are common to many developing nations, clearly identify main obstacles and recommend some practical approaches.

Methodology

This paper utilizes an exploratory-descriptive case study approach using multiple cross-case analyses. It initially applies qualitative analysis approach to secondary data to show positive impacts of modern waste management approaches in some developed countries and then carries out detailed analysis to extract amounts and constituents of generated and collected solid waste in GEMA in order to ascertain valuability of resources which could be recovered from the waste.

Structure of the Paper

The remaining sections of the paper investigate waste management practices of some developed nations, examin-

es waste management practices in GEMA, Ghana; ascertains valuability of resources which could be recovered from the waste and identifies socio-economic benefits of waste-to-resource transformation. It highlights challenges of the waste management system of Ghana, which is similar to many developing countries and proposes a set of practical recommendations on how to improve the situation using waste management practices of developed countries.

SUCCESSFUL WASTE MANAGEMENT PRACTICES

This section briefly examines waste management practices of some developed nations and highlights important key issues.

Garbage Handling in the US

In the United States, where residents pay for garbage handling services, highly automated garbage trucks are like transformers wielding two big “arms”. Some children love to watch them working. So whenever they hear garbage trucks clang, they run out excited for the drama. San Francisco is a garbage handling role model. It is expected that by 2020 the city will have achieved “zero garbage”, which means all garbage recycled. According to a San Francisco-based waste disposal company, coke cans could be used to produce new aluminum cans, leftovers on the table can be transformed into manure and plastic bags can be turned into natural gas, so there is nothing that cannot be recycled in few years (SF Environment, 2011; Andrady, 2003).

Green Life in Britain

In England, people are quite conscious about environmental protection and their garbage mantra is three “R”s (Reduce, Re-use and Recycle). The local governments provide color coded garbage collection cans for recyclable and non-recyclable garbage and households put their old newspapers in a separate bag in order to make their collections easier. In addition, most families use special garbage cans in their homes which can transform kitchen wastes into manure for their lawn. People have also to pay the local governments for collection of their discarded furniture, appliances and other large-sized refuse and littering would lead to a fine of over 100 British pounds which explains the logic behind their garbage mantra (GOV.UK, 2013).

Garbage Handling in France

The concept of three “R”s is also being extensively practiced in France. There are designated areas for discarding items such as furniture, old home appliances and other large-sized refuse that can still be used but their owners do not need them anymore, from where anyone who need them freely take away. Neighbors also tend to share their unwanted goods such as books, roller skates, leather suitcase and snowboard, by putting them in their garage and allowing them to be freely taken away. Furthermore, parents send their children’s clean clothing to the maternal and child care centre from where parents who go there for their kids’ vaccination could pick the clothing they need.

Up until 1996, from among the three well-developed solid wastes management processes of landfill, composting and incineration; household garbage was mainly treated through landfills or composting. But now, high-tech incineration plants which no longer spew billowing black smoke are in service, making garbage incineration an environmental friendly exercise. The Isseane energy-from-waste facility, located in a densely populated Parisian suburb on the banks of the River Seine with a view of the Eiffel Tower, is an example of such plant which has started operating since 2007. With its red exposed masonry, the plant – located only a few kilometers away from downtown Paris – blends harmoniously into the surrounding urban architecture. Its attractive architecture and environmentally friendly technology were the core concerns of the planners (Issy-les-Moulineaux, 2007).

Waste Treatment in Sweden

In Sweden the price of bottled drink includes the deposit of the bottle. The deposit which is 1-2 kroner is indicated on the bottle and has to be paid when the customer buys the drink. At the entrance of supermarkets, there is a specialized device for collecting recyclable bottles. After a bottle goes into the machine, a ticket which indicated the amount of deposit to be returned comes out and that ticket can be used to get the deposit back from the supermarket or deduct the amount from the new shopping bills.

Regarding organic wastes, Swedish law prohibits their purchase as organic wastes have to be treated through biotechnology to become biogas to compost. As such, garbage has become an important source of energy – wastes incineration produces heat and power. Through waste incineration, plants incinerate large amounts of wastes every year and their emissions are close to zero. Norway even exports its wastes to Sweden and for Sweden, the imported waste are a source of both energy and large income in the forms of wastes treatment fee (Avfall Sverige, 2010).

Garbage Handling in Germany

Germany has one of the most systematic waste management schemes and classifies garbage into three

categories of bio-wastes, plastics packing wastes and paper wastes. Bio-wastes refer to various types of organic wastes like fruits, vegetables, meat, fish, leaves, among others and the garbage cans that they should go into have black or brown colors. Plastics packaging wastes are recyclable and should go into yellow colored garbage cans. Paper wastes, including printed materials go into green garbage cans. It is important to sort out different kinds of wastes and put them into the cans they belong to; otherwise neighbors will complain about violators.

Colors of garbage cans are just a nitty-gritty thing. It is important to keep in mind those wastes that need to be handled separately, light-colored glass or plastic bottles and dark colored glass bottles or plastic bottles need to be put into designated recycling bins and batteries have their own exclusive blue recycling bins. Close to every community there is usually a large wastes recycling station which handles cartons, construction wastes, discarded appliances, discarded furniture, scrap metals and so on. Professional staffs are on hand to waste disposers regarding which waste should go into which bins.

A wastes disposal station in the outskirt of Berlin, which handles 30% of the wastes generated by the city, is a textbook example of how wastes go into an accelerated degradation process to become harmless substance and the heat generated in that process is used to support the operation of the station. Reusable materials such as wood and metal are compressed separately and then go to other plants for further processing. Wastes that are difficult to degrade and impossible to recycle go into incineration process and the heat produced in that process can be used to generate power.

Like Sweden, some wastes never go to any waste disposal station. The best example is beverage bottles. Bottled drinks sold at all retail stores and supermarkets usually indicate if the prices include the deposit for the bottles, which is usually 0.25 euro per bottle. Customers can get that 0.25 euro back if they return the bottles to where they bought the drinks or to designated places. For the average Germans, it is an added incentive to get back dozens of euros a month.

The garbage awareness initiative that the German government started two decades ago has paid off and now the Germans, even children, are quite conscious of wastes reduction. However, there are still problems with garbage collection and handling. For examples, wastes are not separated at the airports and railway stations as rationally as in other urban areas. At the same time, different garbage separations standards apply in different parts of the country, making subsequent garbage processing difficult (German RETech Partnership, 2010; FMENCNS, 2006).

Garbage Handling in Japan

Since the corresponding author has spent his entire professional career in Japan and lived in different parts of the country, some personal experiences are also cited. Basically, garbage handling process in Japan is quite similar to that of Germany, as Japan has imitated good German practices and perfected some of them in certain ways. In Japan, household garbage is disposed in color coded disposable plastic bags at community garbage collection sites. Although bio-wastes are collected from the community collection sites by the municipality on their day of disposal for sanitary and health reason, recyclable items are accumulated and voluntarily pre-processed by the community prior to their pick-up by the municipality trucks.

On a rotational basis in many communities, every weekend around 20 representatives from each community gather at their respective garbage collection sites for such community activity which usually last for an hour. Their jobs are to smash collected aluminum cans and separate them from other types of cans; arrange PET bottles, their labels and caps separately; sort out glass and plastic items according to their colors; arrange batteries and other chemical or medical containers separately; punch holes into spray cans; and thoroughly clean the community garbage collection site upon completion of their task. Although the main objective is to make garbage collection task and its recycling process easy and safe, sustain sanitary practice and community health, the activity also provide a regular get together opportunity to the community members. This makes them become more conscious of environmental protection and also keep them aware of community events.

In view of the fact that pre-processed aluminum cans and PET bottles become both easily transportable and attain high commercial value, around 5,000 to 10,000 yen per batch, they have to be kept in locked storage rooms until they are picked up by the municipality trucks. This is because, they are quite attractive to waste scavengers and there have been numerous cases of getting stolen from unlocked storage areas. Now that it has become difficult for scavengers to take away pre-processed aluminum cans and PET bottles from the community waste disposal site, they have turned their attention to disposed old newspapers which are usually left unguarded in the collection sites until they are picked up by the municipality trucks.

Japanese families on the average dispose around 10 Kg of old newspapers per month which has a market value of 80-90 Japanese yen. This translates into a monthly value of around 150 million yen in metropolitan Tokyo and 30 million yen in average Japanese cities. Recent Japanese TV news showed that about 10% of such disposed old newspapers are taken by scavengers from the garbage disposal site in a span of few hours prior to their collection by municipality trucks. Despite the fact that taking away old newspapers is considered illegal and carries a penal of up to 200,000 yen after three warnings, scavengers choose to continue the illegal practice since its profit is much higher than the imposed penalties. The TV news showed how municipality was able to discover coordinated efforts of scavengers through the

Figure 1. Map of Ghana and Greater Accra Region
Source. World and City Maps

use of GPS (OBS Japan, Aug. 3, 2013).

Although Japan is reputed to be one of the cleanest nations in the world and imposes numerous types of taxes on its citizen (national tax, prefectural tax, city tax, value added tax), Japanese municipalities and local governments do not have the culture of providing cleaning services for residential districts. It has become part of Japanese culture to regularly clean their community by picking up stray garbage, fallen leaves and unwanted grass. Such community service, have also become regular activities of school children and retired senior citizens. Considering that an hour long work of 20 community representatives who pre-process aluminum cans and PET bottles is far greater than their commercial value of 5,000 to 10,000 yen, waste management could not become economically attractive without such culture and voluntary services.

WASTE MANAGEMENT PRACTICES IN GEMA

This section examines solid waste management in GEMA; bringing to light the investigated existing practices of solid waste management in the municipality which is similar to many developing countries in certain ways. The main areas of discussion include; detailed description of the area under investigation, amounts and constituents of generated and collected solid waste, current waste management practices, their associated health hazards and some relevant legislations and waste management regulations.

Profile of GEMA and its Main Dump Site

The Ga-East Municipal Assembly (GEMA) is one of the ten (10) districts in the Greater Accra Region of Ghana which itself is the smallest of the 10 administrative regions of Ghana and located on the south-east of the country as shown in Figure 1. The Municipality is made up of over 60 settlements where 82% are urban and peri-urban and there are about 6 health facilities, 4 major markets, 5 notable industries, to mention a few (GSS, 2012).

"Abloradgei" is one of the fast developing settlements in the GEMA which is characterized by its dump site best described by the municipal assembly as a crude, un-engineered final disposal site and thus, another major environmental concern to the Assembly (GEMA, 2009). The dump site is located about 500m west of the main psychiatric hospital in the municipality (which has recently become a general hospital and Nurses Training College) and quite noticeable because of its stink from about 150m away. Most of the waste from various municipalities are transported and managed mainly by Zoomlion Ghana Ltd, a private waste management company.

Status of Waste in GEMA

With increase in population and its associated increase in amounts of waste produced, the waste management issue is becoming of a great concern to the municipal assembly. It has been noted in the municipality's action plan that, expeditious waste generation and indiscriminate waste disposal by inhabitants and pedestrians is one of the development challenges the Assembly has to manage (GEMA, 2009). Most streets, mainly in the highly populated areas, are characterized by filth made up of polythene bags of different colors, food scraps, cans and plastic bottles. The amount of daily waste generated in the region is about 357 tonnes (approximately 0.85kg per capita) which translates to around 130,662 tonnes in a year. The waste is mainly composed of plastics, leftover from foodstuffs, metal containers, bottles and paper boxes just to mention a few

Table 1. Composition of Solid Waste in the GEMA

Component	Composition (%)
Organic	48.8
Plastic	17.9
Paper	9.6
Metals/Tins	9.1
Bottles/Glasses	7.4
Construction/Debris/ Cinder	4.7
Clothing	2.5

Source: Environmental health and sanitation department, 2008.

(GEMA, 2009). Table 1 shows the composition of solid waste generated in the municipality in 2008. These quantities of the categories of waste were obtained from a survey by the Environmental Health and sanitation department of the Municipal Assembly in 2008.

As can be noticed from Table 1, organic waste amounts to about half of the disposed waste. They are mainly disposed by households and markets and there is no form of separation prior to disposal. The door–to–door mode of collection accounts for 81% of the collected solid waste and the rest are gathered through containers placed at vantage points in the communities and at the market places. However, waste collected in this manner constitute only 63% of the total waste; the remainder of which are dumped off indiscriminately in gutters and other open spaces which are subsequently blown by the wind and results in littering of the surroundings.

This situation suggests that GEMA's waste management practice is not consistent with the best practices of developed countries where both householder and manufacturers has the responsibility to ensure that waste are collected and/or returned to the local authority or the manufacturers' waste collecting point (FMENCNS, 2006; Eurostat, 2011).

Waste Treatment Practices in GEMA

There is no recycling of the waste in the municipality. Even though some scavengers move from house to house to collect only metal scraps, the amount of reduced waste by their work is not documented and thereby overlooked. The final destination of the collected waste is a main waste dump site at Abloradgei, also known as Pantang landfill site. The site was envisioned to have an area of fifty (50) acres during its inception, but has now been reduced to about ten (10) acres due to encroaching and sale of lands by land owners to developers.

Health Implications on GEMA

The dumpsite could be noticed from about 150m away because of its foul smell. Such odorous gases pollute the air and because they contain methane, they significantly contribute to greenhouse effect and hence climate change. According to GEMA, the constant unwanted, uncontrolled dumping and burning of the waste at the dump site also creates serious health risks to the people living in the surrounding communities in addition to air pollution. An investigation by Free Africa for Mosquitoes (FAFM) organization in Accra showed that mosquitoes known to transmit malaria and other diseases such as elephantiasis and yellow fever have been breeding at the site (FAFM, 2010).

This should not come with a surprise since malaria continues to top the list of frequent illnesses recorded at the out-patient department of health centres in and around the municipality and accounts for about 40.8% of morbidity in the municipality. Table 2 gives a breakdown of the number of cholera cases and deaths recorded in some districts of the Greater Accra Region as of 31st March, 2011.

Legal Situation of Waste Management in GEMA

According to the administrative personnel of the municipality, there are a few legislations both at the local and the central government level. Local Government Act, 1990 (Act, 462), Water Resources Commission Act, 1996, (Act 522), Environmental Assessment Regulations, 1999 (LI 1652), Ghana Landfill Guidelines (2002), which also apply to the municipality, are suppose to be important waste management regulations in Ghana. However, the biggest challenge is their enforcement which can be traced to unawareness of the people, lack of trained enforcement staff and more especially logistics for policy implementation and its continuous upgrade. Furthermore, the country also lacks other waste management regulations similar to the Packaging Ordinance, End-of-Vehicle Ordinance and the Battery Ordinance of Germany and therefore becomes difficult for the municipal assembly to enforce all stakeholders to take responsibility of the waste management process of the country. Consequently, indiscriminate disposal and handling of municipal waste by households lead to poor sanitation and extreme health risk.

Table 2. Recorded Cholera Cases and Death

Districts	Number of cases	Number of deaths
Accra Metropolis	3,207	33
Ga East	473	1
Ga South	119	1
Ga West	253	1
Adentan	38	0
Ledzokuku Krowor	62	0
Tema	28	0

Source: Yankson, Nathaniel Y., 2011.

DATA ANALYSIS AND DISCUSSION

This section analyzes constituents of generated and collected solid waste in GEMA, identifies resources which could be recovered from the municipality waste and socio-economic benefits of waste-to-resource. It also recommends practical implementation strategy based on lessons learned from developed countries for the hope that it could persuade and commit municipality governments to generate necessary policy, come up with practical implementation strategy and guidelines, educate its citizens, gradually adopt modern waste management approaches and eventually abandon conventional land filling method that is used today.

As shown in Figure 2, the municipal waste of GEMA contains at least eight (8) materials (organic, bottles, glasses, debris, clothing, metal and tins, paper, and plastics) which are recoverable by means of various technologies. It is evident that many materials could be recovered for reuse and recovery of such resources from the waste as it is vital not only to GEMA but also to the country as a whole.

Recoverable Resources - Organic Component

Organic component of GEMA waste constitute the highest fraction of the mixture (about 49% of the total waste) and there are numerous resources which can be recovered from it. Such large organic content of the municipal waste could be put into better use by composting it for agricultural purposes or feeding it into biogas plants to produce energy for use in residential heating and cooking or electricity generation. As was explained in the earlier section, this is already being practiced in most of the developed countries. Through such practice, agricultural land would be saved from pollution; generated manure could be used as fertilizer to further enhance agriculture, the produced energy could reduce reliance on fossil fuels (gasoline, diesel and kerosene) and help reduce deforestation by means of less firewood use.

Demand for energy has been of great concern to all Ghanaians especially as economic activities continue to grow and the population increases. The country has been depending on hydropower and fossil fuel (oil and coal) since late 1960s. However, energy could be generated from municipal waste by either directly burning it or using advanced technology such as mechanical-biological waste treatments (MBT) to optimise feedstock for energy generation (Jaitner, N. and Poll, J., 2006). The generated energy would serve as a substitute for fossil fuel or complement that of hydropower and reduce the cost of energy. Money saved on the use of fossil could then be channeled into developmental projects for the communities like roads, improved agricultural production, hospitals and schools. This would enhance productivity, socio-economic life and reduce poverty in the community.

Recoverable Resources - Nonorganic Component

The remaining 51% of the mixture are non-organic; solid and non-degradable wastes like glass wares, clothing, plastics, paper and various kinds of metals. This component can also be recycled or re-used for several purposes as done in developed countries, but due to lack of education of the inhabitants and absence of proper solid waste management system in the Ga East Municipal Assembly, most of these wastes are not treated sustainably. One of the most challenging issues is the fact that most of these wastes are not separated at their sources (households, offices, market places), thus making their recycling economically infeasible as it requires high cost waste separation plants prior to the recycling.

However, when these non-organic waste materials are recovered through recycling process, the society could reduce its high dependency on natural raw materials. Aluminium, iron and other metallic packages when recovered in this manner will reduce their extraction through mining and promote a society that does not compromise future generations' needs today. Recycling of plastics, paper, cans and bottles would also lead to new types of job creations and involve investors in the waste management by means of collection, sorting and pre-processing. It would enable companies to have quick access to packaging materials and reduce importation of their materials from other parts of the world.

Paradigm Shift: From Waste to Resources

It is evident that constituent of municipal waste of GEMA is not much different from those of developed countries. For example, proper recycling of the 18% of the municipality waste from GEMA which is plastic could have significant impact on socio-economic development of the municipality since it would enhance conservation of

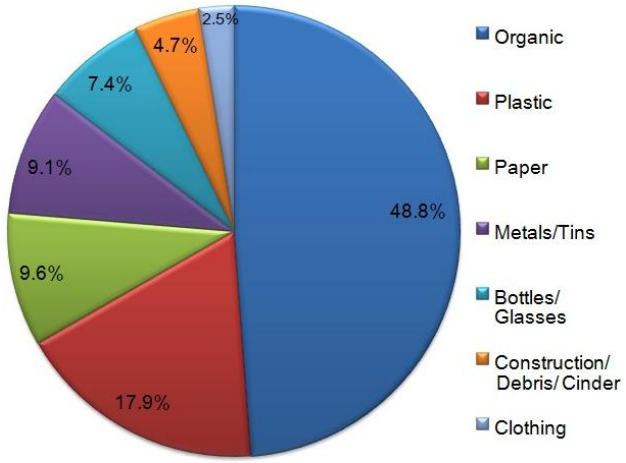

Figure 2. GEMA Municipal Solid Waste for Resources Recovery

natural resources, reduced greenhouse gases (GHG) especially when the plastics are used to produce diesel fuel (UNEP JP, 2013). Plastics and PET bottles can be recycled in an economically feasible manner if segregated from other types of waste at their sources. Reprocessing them into granulate is very easy and PET bottles have a high market value if processing plants are available. Other types of plastics can also be recycled but they have less value on the market than PET bottles and the value would depend on recycling and manufacturing options in the vicinity. Despite the fact that quality of PET bottles and other plastics decrease with every processing cycle and eventually "down-cycling" would have to be practiced after a number of recycles, experiences of developed nations show that such recycling is still attractive even as venture business to new investors when sorting and collection are done properly.

The same is true for the 9.1% metal mixture as it includes aluminum cans, iron scraps and other metallic waste. This is because creating aluminum and metal products from recycled wastes require significantly less energy than producing them through mining. Furthermore, recycling can be repeated infinitely as such materials do not deteriorate from reprocessing. Since 1913 Ghana has been mining bauxite to produce aluminum (Mineral Commission Ghana, 2013). Even though global bauxite deposit is considered the third most abundant metallic element found in the Earth's crust and could last for another 300 years (Foeeurope, 2013; International Aluminium Institute, 2008), aluminium recycling is still very important to sustainable economic development. The reason being that exploration and production of aluminium in Ghana and across the world has led to high deforestation, human right violation, soil degradation and release of toxic materials to the atmosphere which has lead to human health risk and extinction of organisms. In the specific case of Ghana, mining exploration has adversely contributed to the displacement of rural communities, affected their social and cultural orientations and their ability to produce sustainable food products for their family consumption. In some cases, such displaced rural communities were either not compensated or their compensation were delayed for many years. This has in turn destabilized social order and created extreme poverty for affected communities.

Therefore, recycling of aluminum waste found in GEMA municipal solid waste and the country as a whole is quite important for the purpose of minimizing bauxite extraction. In addition, because aluminum wastes are 100% recyclable and use only 5% of the total energy required for its extraction (Foeeurope, 2013), such recycling would significantly benefit GEMA and the country as a whole in terms of energy savings and promoting eco-friendly community. Furthermore, due to high resistance of aluminium to corrosion, recycled aluminium products would support various socio-economic infrastructural developments such as the building industry which is significantly shifting from the use of materials like bricks/blocks and mortar to the use of thick aluminium slate and for other constructional, industrial and transportation products including cars and trains (Foeeurope, 2013). Use of aluminium frames, doors and furniture would also reduce use of timber for these purposes thus reducing community's dependency on virgin wood lands which has led to deforestation and desertification. No wonder most developed countries pay special attention to recycling of aluminium waste and each uses special techniques in order to maximize aluminium recycle rate. Considering that aluminum has a high market value and can easily be recycled by means of shredding and melting, there is no reason why aluminum should not be recycled in GHANA. To recycle aluminum, however, the municipality would need to have an aluminum processing plant. It is needless to say that economic feasibility of setting up such plants and operating

them sustainably would depend solely on proper sorting of aluminum waste at their sources.

The same thing holds true for clothing and paper waste which constitutes over 12% of the municipal solid waste in GEMA and presently go into land filling at the dumpsite. This is because paper is generated from wood, recycled paper could reduce community's dependency on virgin wood lands and help improve deforestation problem. Furthermore, properly sorted paper waste can be as attractive as aluminium as far as its recycled commercial value is concerned since even in developed countries like Japan, which has one of the lowest unemployment rate and one of the highest per capita income in the world, sorted paper waste has to be kept in guarded places due to their attractive recycle values. As paper or cardboard produced from recycled paper requires less energy, recycled paper becomes more profitable raw material to produce end products. As for the clothing waste, if they are properly handled, it could support the needy and reused by orphanages as being done in many developed countries. Other sorted grades of clothing waste can be used as insulators in furniture, cars and in the construction industry. Through such recycling practices, the community could reduce the poisonous pesticide and huge amount of water used for cotton farming and textile processing respectively. It is important to underscore that "water is life" and therefore this practices would help reduced the water burden and frequent shortage of community water supply.

Finally, a similar analogy can be stated for recycling of glass and debris as they also constitute over 12% of the municipal solid waste in GEMA and presently go into land filling at the dumpsite. Glassware productions using recycled glass can save energy compared with producing them from raw material. Like aluminum and other metals, glass can be recycled indefinitely because it does not deteriorate from reprocessing. Recycled glass, however, has a moderate market value and need to be sorted into colors prior to melting process. Debris and demolition waste can be crushed to gravel for reuse in road construction and landscaping. As they require machinery for crushing, maintenance of which is quite intensive, recycling such waste could become valuable when there is a lack of other construction material.

CONCLUSION AND RECOMMENDATION

Waste management has become an essential part of city management due to increased waste management problems and among the three well-developed waste management techniques of landfill, composting and incineration, land filling is the least preferred waste management method due to its unsafe nature and continued degradation of the environment.

In advanced countries such as Germany, Japan, US and some EU member states, waste is not considered as waste but a material from which valuable resources are recovered by means of recycling, composting and incineration. People are also made aware of the importance of environmental protection and the concept of three "R"s (Reduce, Re-use, Recycle). Furthermore, proper sorting of the waste at their sources is systematically carried out to ensure that waste recycling business stays as an economically feasible and commercially attractive venture to new investors.

A detailed investigation through a case study on GEMA, Ghana, revealed that GEMA municipal solid waste also contains numerous valuable resources, proper extraction of which could improve socio-economic situation of the country by creating new types of jobs, alternative products from recycled materials, reduce climate change, lessen the use of virgin resources and involve investors in the waste management business. Despite this, however, the municipality currently practices conventional land filling, there exists no modern treatment or resource recovery system and indiscriminate waste disposal by inhabitants and pedestrians continually swells with increase in population. The main cause for all of these are traced to lack of education of the inhabitants and absence of waste separation system at their sources both of which adversely influence commercial feasibility of recycling and modern waste treatment approaches.

In order to improve waste management systems in GEMA and other similar places, both soft and hard infrastructures are needed. The soft infrastructures could come inform of appropriate education, training, guidelines, policies and governance systems. Educating citizens about the importance of sustainable waste management system, involving them in its process and committing them to properly sort municipal waste prior to its disposal at community garbage collection sites, is essential to make recycling business attractive to investors. The hard infrastructure involves tangible infrastructures necessary to build a formidable, effective and efficient waste management system similar to those in the advanced societies. This would include necessary logistics, waste processing plants, waste management vehicles, appropriate and sufficient collection bins, incinerators and the right tools necessary collection bins, to ensure that high volume of waste are collected, sorted and processed toward a sustainable resource recovery. Initial government subsidy may be needed, but once the recycling business becomes economically feasible and commercially attractive venture to investors, the operation will continue on self sustainable manner.

ACKNOWLEDGMENT

The authors wish to thank Prof. Susanne Hartard and all other faculty members of the Graduate School of Asia Pacific Studies of Ritsumeikan Asia Pacific University (APU) and the Umwelt Campus Birkenfeld of the University of Applied Sciences who supported this work provided valuable feedbacks. We are also grateful to the Municipal Chief Executive, Hon. John Kwao Sackey, the

Municipal Director, Mr. Dickson Abiti and all the staff of the sanitation department of the Ga East Municipal Assembly for their support in my work. Finally we would like to thank the anonymous reviewers for their comments that helped us significantly improve this paper.

REFERENCES

Andrady Anthony L (2003). "Plastics and the Environment", Hoboken, NJ: John Wiley & Sons, 2003.

Avfall Sverige (2010). "Swedish Waste Management", Retrieved from http://www.avfallsverige.se/fileadmin/uploads/Statistikfiler/SWM2010.pdf on 29th August, 2013.

Environment Canada (2013). "National Inventory Report 1990–2011: Greenhouse Gas Sources and Sinks in Canada", Environment Canada, Ottawa, ON.

EPA (2009). "Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2008", Solid Waste and Emergency Response (5306P) Washington, DC 20460.

Eurostat (2011). "Manual on waste statistics: A handbook for data collection on waste generation and treatment", Publications Office of the European Union, 2011.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (FMENCNS, 2006). "Waste Management in Germany: A Driving Force for Job and Innovation", Retrieved from http://www.cleaner-production.de/fileadmin/assets/pdfs/_73_Engl.__broschuere_abw_deutschland_01.pdf on 7th June, 2013.

Free Africa From Mosquitoes (FAFM, 2010). "Report on Larval Survey & Larviciding at The Pantang Refuse Dump Site".

Friends of the Earth Europe (Foeeurope, 2013). "Less is more: Resource efficiency through waste collection, recycling and reuse of aluminium, cotton and lithium in Europe", Retrieved from http://www.foeeurope.org/sites/default/files/publications/foee_report_-_less_is_more_0.pdf on 29th August, 2013.

Ga East Municipal Assembly (2009). "Municipal Environmental Sanitation Strategy and Action Plan".

Ga East Municipal Assembly (2008). "Environmental health and sanitation department, Annual report".

Ghana Statistical Service (GSS, 2012). "2010 Population and Housing Census (PHC)", Retrieved from http://www.statsghana.gov.gh/docfiles/2010phc/2010_POPULATION_AND_HOUSING_CENSUS_FINAL_RESULTS.pdf in 2013.

German RETech Partnership (2013). "Recycling & Waste Management in Germany", Retrieved from http://www.retech-germany.net/english/service/latest_news/dok/373.php in 2013.

GOV. UK. (2013). "Reducing and managing waste", Department for Environment, Food & Rural Affairs, Retrieved from https://www.gov.uk/government/policies/reducing-and-managing-waste in 2013.

International Aluminium Institute (2008). "Fourth Sustainable Bauxite Mining Report", Retrieved from http://world-aluminium.org/media/filer_public/2013/01/15/none_23 on 9th June, 2013.

Issy-les-Moulineaux/France (2007). "Energy-from-Waste Plant", Isséane – environmentally friendly plant with a view of the Eiffel Tower, Retrieved from http://www.hz-inova.com/cms/images/stories/pictures/download/hzi_ref_issy_en.pdf on 25th July, 2013.

Jaitner N, Poll J (2006). "Mechanical Biological Treatment of Municipal Solid Waste", Biomass and Bioenergy, IEA Bioenergy Update 33, Elsevier, October 2006.

Kallman M (2008). "Talking Trash: The World's Waste Management Problem", June, 2008. Retrieved from http://earthtrends.wri.org/updates/node/314, in 2011.

Minerals Commission (2013). "Manganese, Bauxite and Iron Ore Occurrence in Ghana", Retrieved from http://www.ghana-mining.org/GhanaIMS/LinkClick.aspx?fileticket=zXkGaz4c3Xo%3D&tabid=36&mid=930, in 2012.

Nadakavukaren A (2006). "Our Global Environment", A health perspective, (6th edition). Waveland press inc. USA.

SF Environment (2011). "Zero Waste FAQ", Department of City and County of San Francisco, Retrieved from http://www.sfenvironment.org/zero-waste/overview/zero-waste-faq on 8th July, 2013.

Uriarte F A Jr (2008). "Solid Waste Management: Principles and Practices", E.de los Santos St., UP Campus, Diliman, Philippines.

UNEP JP. (2013). "Part I Principles of Municipal Solid Waste Management", Retrieved from <http://www.unep.or.jp/ietc/Publications/spc/Solid_Waste_Management/Vol_I/5_6-Part1_Section-chapter1.pdf in 2012>.

Versilind P, Aarne W, William A, Reinhart D R (2002). "Solid Waste Engineering", Brooks/Cole of Thomson Learning Inc. USA.

World Waste Systems (2012). "Municipal Solid Waste Recycling", Retrieved from http://www.worldwastesystems.com/index.htm in 2013.

World and City Maps (2013). "Republic of Ghana Google maps and facts", Retrieved from http://www.worldandcitymaps.com/africa/ghana/ on 24th December 2013.

Young Gary C (2010). "Municipal Solid Waste to Energy Conversion Processes: Economic, Technical and Renewable Comparisons", Hoboken, NJ: John Wiley & Sons, 2010.

Zerbock O (2003). "Urban Solid Waste Management: Waste Reduction in Developing Nations", Msc Thesis, Michigan Technological University.