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Comparison of municipal solid waste management systems in Canada and Ghana: A case study of the cities of London, Ontario, and Kumasi, Ghana

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ABSTRACT

Integrated waste management has been accepted as a sustainable approach to solid waste management in any region. It can be applied in both developed and developing countries. The difference is the approach taken to develop the integrated waste management system. This review looks at the integrated waste management system operating in the city of London, Ontario-Canada and how lessons can be drawn from the system's development and operation that will help implement a sustainable waste management system in the city of Kumasi, Ghana. The waste management system in London is designed such that all waste generated in the city is handled and disposed of appropriately. The responsibility of each sector handling waste is clearly defined and monitored. All major services are provided and delivered by a combination of public and private sector forces.

The sustainability of the waste management in the city of London is attributed to the continuous improvement strategy framework adopted by the city based on the principles of integrated waste management. It is perceived that adopting a strategic framework based on the principles of integrated waste management with a strong political and social will, can transform the current waste management in Kumasi and other cities in developing countries in the bid for finding lasting solutions to the problems that have plagued the waste management system in these cities.

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1. Introduction

Municipal solid waste management (MSWM) over the years has been undertaken with many drivers world wide. The objectives of MSWM have evolved from the primary concerns of environmental health protection to considering human safety, resource conservation and the reduction of, as much as possible, the environmental burdens of waste management (energy consumption, pollution of air, land and water and loss of amenity) (McDougall and Hruska, 2000). Increasing waste generation rates due to population growth, changing lifestyles of people, development and consumption of products with materials that are less biodegradable have led to the diverse challenges for MSWM in various cities of the world. Distinct differences have been identified in literature between MSWM in developed and developing countries. In most developed countries, public health is no more a major driver of waste management; the current focus is on optimization of waste management practices with a broader goal of resource conservation (Wilson, 2007; McDougall et al., 2001). MSWM in most developing countries is often characterized by inadequate service coverage, operational inefficiencies of services, limited utilization of recycling activities, inadequate management of non-industrial hazardous waste and inadequate landfill disposal (Zurbrügg and Schertenleib, 1998). Although distinct differences exist between waste management in developed and the developing countries, as developing countries achieve economic growth coupled with population growth the environmental and economic burdens of solid waste management will increase. According to UNEP (2005) the rate of waste generation generally increases in direct proportion to that of a nation's advance in development and failure to provide a management system could result in greater environmental degradation with increase health risk to the urban population. There is the need for developing countries to be guided in taking the appropriate steps in developing sustainable waste management systems. This is important owing to the fact that the more the environment is degraded in a particular region, the greater the effort that will be required to restore its quality (UNEP, 2005). Lessons can be drawn from experiences in developed countries to guide developing countries as they seek to improve on existing MSWM systems, since waste management systems have evolved through many steps over the years in developed countries (Wilson, 2007). It is becoming widely recognized that an integrated approach to waste management leads to the sustainability of the waste management system. The concept of integrated waste management (IWM) according to McDougall et al. (2001) takes an overall approach and manages waste in an environmentally effective, economically affordable and socially acceptable way. It involves the use of a range of different treatment options at a local level and considers the entire solid waste stream. An IWM approach is broadly evident in the waste management system in most developed countries (McDougall et al., 2001). Some initiatives towards IWM in developing countries have been reported which were mostly organized by non-governmental organizations for sections of some cities. In order to support the adoption of the IWM approach on a city wide basis in developing countries, it would be useful to present a specific case study or an example of the development and implementation of an integrated waste management system for a city in a developed country. The experiences and lessons learned could be utilized as a basis to develop a framework for implementing successful IWM system in developing countries. This paper seeks to add to the discussion of the adoption of the IWM approach on a city wide basis in developing countries, using an example from a municipality in a developed country for comparison. By learning lessons from the experiences in a developed country, waste management experts and regulators in developing countries can also avoid past mistakes made by developed countries, in the evolution of waste management practices.

The aim of this paper is to provide an overview of the different elements of municipal solid waste management in London, ON (referred to as London in the rest of the paper), Canada and Kumasi, Ghana with the discussion of possible lessons that can be adopted from the MSWM system in London to help develop an IWM system in Kumasi. Background information on the two cities is presented to enhance an understanding of their characteristics. To enable the comparisons between waste management in the two cities, the existing waste management systems are described in terms of waste generation, waste composition, waste collection methods, service coverage and transportation, waste treatment and disposal, municipal solid waste management strategic plan and government laws and regulations. The description of the waste management systems in the two cities was carried out with information from reports, documents obtained from the official websites of the city authorities and personal communication with the authorities responsible for waste management in the cities.

The MSWM systems in London and Kumasi are then discussed in terms of the key features of IWM and common system drivers identified in case studies of IWM studies presented in McDougall et al. (2001). Some concluding thoughts are then put forward as to how the city of Kumasi can develop an IWMS based on the success features adopted by the city of London.

2. Description of the city of London, Ontario (ON) and Kumasi

2.1. Background Information on the city of London, ON

The city of London is located in the heart of southwestern Ontario, Canada. The city covers a land size of 420.57 km^2 with an elevation of 251 m. London has a humid continental climate. Because of its location in the continent and proximity to the Great Lakes, London experiences very contrasting seasons. The summers are usually warm to hot and humid while the winters are normally quite cold but with frequent thaws. For its southerly location within Canada, it does receive quite a bit of snow, averaging slightly over 200 cm (80 in.) per year. The city of London is the 15th largest city in Canada and 6th largest in the province of Ontario with a population of 352,395 people as of the year 2006 (Steblin and Stanford, 2008; City of London, 2009).

2.2. Background information on the city Kumasi

Kumasi is the 2nd largest city in Ghana after the national capital city, Accra. Kumasi is located in the transitional forest zone and is about 270 km north of the national capital. It is between latitude 6.35–6.40° and longitude 1.30–1.35°, an elevation which ranges between 250 and 300 m above sea level with an area of about 254 km^2. The average minimum temperature is about 21.5 °C and a maximum average temperature of 30.7 °C. The average humidity is about 84.16% at 0900 GMT and 60% at 1500 GMT. The city has a double maxima rainfall of 214.3 mm in June and 165.2 mm in Sep-

tember. The Kumasi Metropolitan Area has been estimated to have a daytime population of about 2 million. It has been projected to have a population 1,610,867 in 2006 and 1,889,934 by 2009 based on a growth rate of 5.47% per annum. The growth of industries and the large volume of commercial activity in and around Kumasi as well as the high migrant number may account partly for the relatively high urban population. The Metropolis falls within the wet sub-equatorial type (Ghanadistricts, 2008).

3. Municipal solid waste management system overview in London, ON and Kumasi

3.1. Waste generation

On the average, 1.2 kg per capita of household solid waste is generated in the city of London per day. The estimated daily municipal waste generation rate in Kumasi is 0.6 kg per capita. In the year 2006, a total of 267,000 tonnes of both residential (58%) and non-residential (42%) waste was managed in the city of London as against 365,000 tonnes generated in Kumasi. It is estimated that households generate the highest amount of waste in Kumasi, followed by Markets, then industries with the least from institutions although the exact proportions could not be provided. The waste generation rate in the municipality is expected to increase by 15% by the year 2010 (WMD-KMA, 2008). Although the per capita waste generation in Kumasi is lower than that of the city of London the large population in Kumasi makes the overall waste generated in Kumasi higher than that of London.

3.2. Waste composition

The composition of household waste in the city of London and Kumasi is shown in Table 1. The available waste composition data for London was for household waste only; other non-residential waste handled by the city authority is not included. The composition of waste available for Kumasi is for the total municipal waste. Although the waste composition for London is not for the entire waste streams, comparing it with waste composition from Kumasi shows the characteristic difference in waste composition from developed and developing countries. The composition of waste in Kumasi is predominantly made of biodegradable materials and a high percentage of inert materials as well. The inert material is mostly made of wood ash, sand and charcoal. Paper and organic waste dominate household waste in London and are present in almost equal proportions. London also has a higher percentage of recyclables. These differences in waste composition may be attributed to the differences in the living standard and lifestyle of the inhabitants of the two cites. The abundance and type of the natural resources found in the countries of the two cities may also reflect in differences in the waste composition (UNEP, 2005).

Table 1
Available waste composition data in London, ON and Kumasi.

Waste component	London, ON[a] (%)	Kumasi[b] (%)
Biodegradable/organic	30	64
Paper	32	3
Plastic	10	4
Metals	3	1
Glass	6	–
Others	19	–
Inert	–	22
Wood	–	3
Textiles		3

[a] Household waste average (garbage and recycling combined from waste audits) for 2005 and 2007 for the city of London (City of London, 2007).
[b] Waste (total municipal) composition in Kumasi (WMD-KMA, 2008).

3.3. Waste collection methods, service coverage and transportation

The city of London provides waste management services to all residents of the city. To ensure the collection of all waste generated in the city, guidelines have been provided to residents of the city on how to handle the various types of waste that are generated. Eighty percentage of the population is served by curbside garbage (garbage is defined here as the residual waste after blue box recyclables have been separated from household waste) collection, whilst 20% are served by multi-residential & public space garbage pickup. The curbside garbage pick up is carried out by 17 rear loading packers (trucks) and 2 side loading packers. Multi-residential and public space pick up is carried out by two front loaders and two rear loading packers. There also exists the blue box recycling program for the collection of recyclables in the city. The blue box recycling materials are collected on the same days that garbage is collected. Materials collected in the blue box program include: boxes (cereal, detergent, cracker, etc.), paper, cardboard, aluminum containers and foil, glass, steel, plastic (number 1, 2, 4 or 5), milk and juice cartons. Special days are provided for curbside collection of yard waste (plant trimmings, grass clippings, leaves and branches) in the year. There are five depots located throughout the city for residents to dispose of various waste streams. Provision has been made for the disposal of household special waste (any material that is corrosive, flammable, ignitable or reactive) at the city's landfill. The city also offers garbage collection to about 1500 small businesses.

Two types of methods are employed for the collection of municipal waste in Kumasi. These are the house-to-house (curbside) solid waste collection utilizing compactor trucksand communal solid waste collection. The Communal Collection System involves the location of metal containers (skips) at designated sites known as transfer stations, which are shared by a number of houses within that community. When the skips are full, they are transported and emptied at final disposal site by skip loading trucks. Collection of waste from institutional and industrial premises also relies on container services. Eighty-five percentage of the waste generated is collected in the municipality. The waste collection service in the city is carried out by the private sector under various agreements with the metropolitan assembly.

3.4. Waste treatment and disposal

Waste collected in the city of London as garbage is disposed off in the city's landfill.

In the year 2006, 205,000 tonnes of wastes was disposed of in the city of London's "W12A" landfill, from residential (45%), city

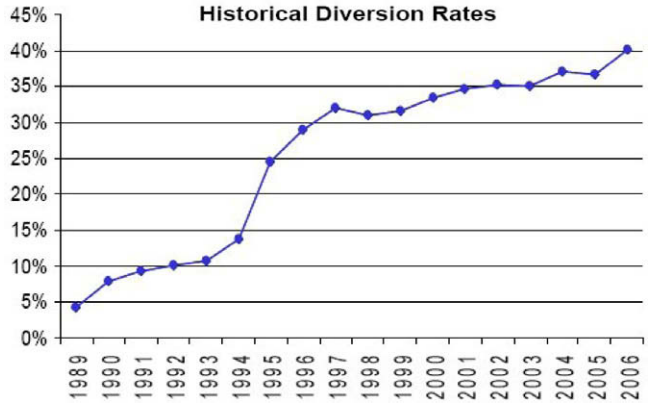

Fig. 1. The city of London's Historical Waste Diversion rates (City of London, 2007).

Table 2
Initiatives introduced in London, ON to achieve 40% diversion (Steblin and Stanford, 2008).

Year	Initiative
1987	Household special waste depot
1990	Curbside blue box pickup
1994	Appliances banned from garbage collection
1995	Added new items to blue box
	Grass clippings banned from garbage collection
1996	Curbside pickup of yard materials
2000	Multi-residential building recycling
	Pumpkin depots
2002	Electronics recycling depot
2003	Public space recycling
2005	Renovation material recycling accepted at enviro-depots
2006	Four container limit for garbage

Table 3
City of London programs – facility ownership (Steblin and Stanford, 2008).

Waste management facility	Facility ownership	
	Public sector (%)	Private sector (%)
Multi-material drop-off depots	100	0
Material recovery facility (MRF)	0	100
Yard materials composting facility	0	100
Household special waste depot	100	0
Landfill site	100	0
Closed landfills	50	50

Table 4
City of London programs – service providers (Steblin and Stanford, 2008).

Service	Service provider	
	Public sector (%)	Private sector (%)
Administration, awareness and education	100	0
Recycling collection	0	100
Recycling processing	0	100
Yard materials collection	98	2
Yard materials composting	0	100
Household special waste depot	70	30
Closed landfill management	65	35
Garbage collection	98	2
Landfill management and administration	100	0
Landfill site operations	30	70

Table 5
Waste diversion costs – 2006 (Steblin and Stanford, 2008).

Diversion program	Tonnes managed	% Diversion	Net program cost ($)
Recycling – curbside	24,850	16	1,300,000
Recycling – multi-residential	2800	2	500,000
Leaf and yard waste composting	16,100	10	1,400,000
Other diversion programs	18,250	12	400,000
Total	62,000	40	3,600,000

Note: Does not include indirect costs.

operations (25%), brownfield (3%) and businesses (27%). The recyclables collected by the blue box program are transported to a materials recovery facility (MRF) in the city where they are sorted, baled, placed on transport trucks and shipped to end markets to be turned into new products. Ninety-eight percentage of recyclables set out are shipped to end markets and only 2% of it ends up in the landfill.

The city of London's waste management system, as of the year 2006, diverted 40% of waste from the landfill. The city of London's Historical Waste Diversion rates is shown in Fig. 1. A number of initiatives introduced to achieve this diversion rate from 4% in 1989 are shown in Table 2. Recycling contributed 18%, curbside depots and self management of yard waste 17%, and other programs, as enumerated in Table 2, 5% to the 40% diversion rate achieved by the year 2006 in the city of London. The city of London utilizes both public and private sector facilities to manage the waste generated in the city. Table 3 presents the facilities available for waste management in the city and who owns them. The provision of waste management services in the city is also undertaken by both the public and private sectors. Table 4 gives the picture of how these services are divided between the two sectors. The city of London is considered to be one of the cities with the lowest waste management costs in the province of Ontario. The waste diversion costs and the waste management system cost for the city of London in the year 2006 is indicated in Tables 5 and 6 respectively.

The waste collected in Kumasi is disposed of at two sites with a capacity of 4,587,456 m^3; a sanitary landfill site and an open dump. The sanitary landfill is constructed on a 100 acre land and treats both solid waste and sewage. The sanitary landfill is managed by a private contractor on behalf of the city authority. Waste diversion through recycling and reuse is carried out on an informal basis which is not widely recognized as contributing to waste management in the city. The estimated cost of operating the landfill is US$ 250,000/month excluding the cost of land use and facility closure. The government bears 95% of the landfill management cost. The average waste collection costs US$ 350,000/month with waste generators bearing 15% and the municipal authority 85% (WMD-KMA, 2008). The total annual waste management cost is approximately US$7.2 million.

3.5. Municipal solid waste management (MSWM) strategic plan

The waste management system in the city of London is based on continuous improvement strategy (management philosophy) and sustainable waste management.

The London municipal council approved this long-term waste strategy in December 1997. According to Stanford (2000), the continuous improvement strategy is a dynamic framework that recognizes integrated waste management as an important environmental service in the community which contributes to the protection of human health and the environment. The implementation of the strategy involves the annual establishment of community needs and priorities, monitoring of the existing and other waste management systems, implementation and assess-

Table 6
Waste management costs – 2006 (Steblin and Stanford, 2008).

Component	Tonnes managed		Gross cost ($)	Fees and revenues ($)	Net program cost ($)
	Residential	Non-residential			
Waste Diversion	62,000	0	7,700,000	4,100,000	3,600,000
Collection	92,600	0	8,400,000	400,000	8,000,000
Landfill Disposal Operations	92,600	112,400	3,300,000	1,800,000	1,500,000
Miscellaneous (closed landfills, reserve fund, etc.)	92,600	0	2,800,000	0	2,800,000
Total			22,200,000	6,300,000	15,900,000

ment of approved initiatives, and utilization of various methods of communicating results. Two major elements of continuous improvement are the establishment of annual and short-term goals and systematic framework for evaluating system performance (environmental and economic). Annual and short-term system goals include: minimizing the production of garbage, minimizing the environmental burden of the overall system, minimizing costs to taxpayers and maximizing opportunities for new business. The systematic framework is designed to annually monitor the existing system for several environmental parameters and costs, monitor other comparable jurisdictions, obtain input and feedback from the system users, evaluate potential new waste management components and implement approved waste management components. The performance of the waste management system is measured in the diversion rate, life cycle analysis of environmental benefits, cost per tonne landfilled or cost per tonne diverted, customer satisfaction, capture rate, etc.

The Kumasi Metropolitan Assembly produced a strategic sanitation plan for Kumasi for the period 1990–2000 which was later reviewed and extended for the period 1996–2005. The component of solid waste management within the plan seeks to develop a landfill for the city and to engage the private sector in waste management services. These have, so far, been achieved in the city. No specific plan exists solely for waste management in the city with targets to meet and indicators to measure its progress.

3.6. Government laws and regulations

In the province of Ontario, the provincial government provides regulations and policies for waste management. Key provincial legislations pertaining to waste management are 3Rs Regulations (under the Environmental Protection Act) and Waste Diversion Act. Ontario's 3Rs Regulations were passed in 1994 and outline specific minimum waste management requirements for municipalities, industry and institutions. In 2002, under the Waste Diversion Act, Waste Diversion Ontario was formed to support the development, implementation and operation of waste diversion programs for materials including blue box materials, used tires, used oil, household special waste and electronic and electrical equipment. In 2004, the provincial government set a goal for all Ontario municipalities and businesses to divert 60% of the Province's waste. The local government (municipal government) passes bye-laws, delivers or contracts for services and uses taxes and fees to pay for services to meet provincial regulations. The bye-laws that govern waste management in the city of London are the municipal waste and resource material collection bye-law (provides regulation for the collection of municipal waste and resource materials in the city) and the waste management system fees and charges bye-law (provides for imposing fees and charges for services, activities and use of the city's waste management system).

No distinct law has been identified in Ghana for the management of solid waste; however, some key policy documents exist. Available key national policy documents pertinent to solid waste management are the National Environmental Sanitation Policy (prepared by the Ministry of Local Government and Rural Development in 1999 to develop and maintain a clean, safe and pleasant environment for human settlements), Guidelines for Landfills/Safe and Sound Management of the Bio-Medical Wastes in Ghana (drawn up by the environmental protection agency to establish standards for design, construction and management of waste disposal systems to protect public health and the environment) and Manual for the Preparation of District Waste Management Plans in Ghana. The Kumasi Metropolitan Assembly has bye-laws related to the handling of wastes, which are deemed to be outdated particularly in terms of penalties. The enforcement of these bye-laws has also been weak.

3.7. Challenges for MSWM in Kumasi as enumerated by city authorities

Current challenges to waste management in Kumasi that city authorities face are:

- Inadequate funding for capital investment for effective delivery of waste management services.
- Inadequate equipment holding culminating in limited coverage of service delivery
- Inadequate bye-laws and lack of enforcement of available ones.
- Inadequate revenue mobilization to finance Waste Management Service costs.
- Bad attitude of residents such as indiscriminate disposal of household waste and littering due to lack of effective environmental health education and service promotion strategy.
- Poor infrastructure, particularly road networks and waste collection points, mostly in new settlements, which impacts negatively on service delivery.

4. Comparison of the two MSWM systems

The waste management systems in the cities of London and Kumasi typically describe the situation of waste management in developed and developing countries. The trends evident globally in waste management are described in Wilson (2007) as developed countries exhibit a high degree of sound environmental considerations in their waste management utilizing sanitary landfills, waste treatment and processing, energy and material recovery options whereas waste disposal is uncontrolled and waste treatment, processing, energy and material recovery are rare in developing countries.

The MSWM systems in London and Kumasi are discussed in terms of the key features of IWM and common system drivers identified in case studies of IWM presented in McDougall et al. (2001). These key features of IWM include the utilization of an overall approach, the use of a range of collection and treatment methods and handling of all materials in the waste stream in an environmentally effective, economically affordable and socially acceptable manner. The system drivers identified by waste managers include: good system management, vision, stability, critical mass, landfill space, funding, legislation, control of all solid wastes and public opinion and communication. The key IWM features and system drivers are combined for the discussion of the two waste management systems as follows.

4.1. Good system management

It is asserted in UNEP (2005) that, in many instances in developing countries, the largest impediments to efficient and environmentally sound handling of MSWM are managerial, rather than technical. Improving the operational and management capabilities of individuals and institutions involved in MSWM at the local level is therefore extremely important. A good system management is discussed here as a system that takes an overall approach and has vision and stability. The city of London exhibits good system management by adopting the continuous improvement strategy for waste management in the city. It has well defined long and short-term goals and has put in place a strategic framework for achieving these goals. The system collects essential data that is utilized in monitoring progress and finding ways for improvement. The political framework of the city provides stability and avoids unnecessary interference in the waste management system. All city staff including senior staff are paid employees and are not elected or appointed by government (Steblin and Stanford, 2008), hence are not affected by the political process making them independent and providing stability for the waste management system.

In order to achieve long-term stability, the city of London owns the landfill which is a key facility in the waste management system. In Kumasi, the strategy for solid waste management is not well defined. Possible actions to improve waste management are broadly mentioned in the strategic sanitation plan of the city without specific immediate goals and a framework to achieve the goals. Data on waste management is scanty. The highly politicized administration of the city can sometimes interfere with long-term waste management projects in the city. A lesson that can be drawn from the city of London to provide a clear pathway and stability for the establishment of a sustainable waste management system in Kumasi is the drawing up of a waste management plan for the city. This could be done after careful assessment of all waste produced in the city and available infrastructure. A system must be put in place to collect regular data on the performance of the waste management services which could then be used to annually assess the performance of the waste management system and to identify possible points of intervention. Instituting a good management system will require training of staff that will be highly motivated and determined to provide practical solutions to the challenges in the waste management of the city.

4.2. Control and handling of all wastes generated

The city of London, with a per capita household waste generation of 1.2 kg/day and a population density of 837.9 persons per km^2 in the year 2006, handled a total of 267,000 tonnes of waste, as compared with the 365,000 tonnes generated in Kumasi with a per capita waste generation of 0.6 kg/day and a population density of 6342 persons per km^2. This comparison shows that, although Kumasi has a lower per capita waste generation rate due to the higher population, the total amount of waste to be managed is greater than that of the city of London. This clearly indicates the amount of waste handled in an urban area of a developing country is no less than that handled in a developed country; hence there is an urgent need for instituting integrated waste management systems in both urban settings. The use of a range of collection and treatment methods in the city of London ensures that the entire waste generated in the city is accounted for, while over 15% of waste generated in Kumasi is not collected or accounted for. The two systems of waste collection in Kumasi could be carefully evaluated and optimized for the different sections of the city to ensure that all the waste generated in the city is accounted for. The bye-law for waste and resource material collection for the city of London holds the municipal authority and the citizens accountable for the handling of all wastes generated in the city. This ensures control of all the waste in the city. The waste handling bye-law for Kumasi needs to be revised, as noted by the city authority. In revising the bye-law, the responsibilities of both citizens and the local authority should be clearly defined with stringent and appropriate penalties that will facilitate compliance as is seen in the city of London's waste management bye-laws.

4.3. Consideration of critical mass for system design

Scarcity of land for landfills and stringent environmental regulations drove many cities in developed countries to develop integrated waste management systems with the goal of reducing the amount of waste going to landfills (McDougall et al., 2001). The reduction of waste generation has been a major driver of the waste management approach in the city of London. In view of the bottlenecks involved in the development of new landfills, the city authorities targeted the reduction of amount of waste that is landfilled in order to extend the life of the existing landfill. This led to the rigorous waste diversion program that is being implemented in the city. The evolution of the waste diversion program in London shows the ability to develop appropriate infrastructure in relation to the types and quantities of materials available for waste diversion. It is ensured that the method of collection of particular waste materials corresponds to the quantities of these materials in the waste stream and the availability of end markets for these materials. Kumasi is one of the only municipalities in Ghana that can boast of having an engineered sanitary landfill. Although at present the issue of disposal space has been resolved, there is still the need to divert materials from the landfill in order to prolong the life of the landfill due to the increasing amounts of waste and increasing non-biodegradable materials in the waste stream. As the private sector is involved in the collection of waste in Kumasi, waste diversion programs could be explored in collaboration with the existing informal sector involved in waste recycling in the city. A rigorous analysis of various locally developed waste collection and resource recovery strategies with community involvement could probably reduce the amount of waste that is unaccounted for, collected and transported to the landfill. Strategies for the collection of materials must be based on the availability of these materials in the waste stream in quantities that will make the cost of collection worthwhile. Private sector involvement in the development of waste diversion in Kumasi could be more effective if the environment created is competitive and there is a way to monitor performance and provide accountability.

4.4. Environmentally effective system

A unique feature of the city of London's waste management system is the use of a computer model to measure the environmental performance of the total municipal waste management system. The computer model "Integrated Waste Management (IWM) Model" was developed by Corporations Supporting Recycling (CSR) and the Environment and Plastic Industry Council (EPIC) with their technical consultants, Proctor & Redfern and Environsphere, in cooperation with the city of London and Environment Canada. The progress made in the city of London in reducing the environmental impacts of the waste management system are clearly shown from the model results produced for the city for the years 1995–2006 (City of London, 2007). As part of the continuous improvement strategy adopted the city of London is committed to ensuring the reduction of the environmental impacts of its waste management system. Although the waste management system in Kumasi seeks to protect the environment, there is no system in place to evaluate the impacts of the waste management system on the environment. An assessment of the environmental performance of the waste management system will be a good indicator of the progress made in waste management in the city if it is considered by the city authorities.

4.5. Economically affordable system

The waste management system in London is funded in a number of ways. General property taxes are the largest contributor to the funding of residential waste management. In 2006, 72% of the gross cost of residential waste management was covered by property taxes, 25% by recycling revenues and recycling payment from industry and 2% from fees from some services like 4-yard garbage bin rentals and extra service payment for multi-residential garbage pickup. As future waste diversion is planned for the city, high percentage of property taxes is not viewed as a sustainable option of funding by the city administration. The city administration is considering various sources of revenue including increasing property taxes, introducing flat rate or user fees, increasing landfill tipping fees and/or seeking additional funding from government and industrial sources. Funding for waste management in Kumasi has been mostly provided by government subsidies and city

revenue, only 15% of service costs is paid by households whose waste is collected under the door-to-door scheme. This has been indicated as one major problem that undermines the waste management system. There is the need to evaluate various funding schemes in order to improve service delivery. The involvement of the private sector to provide waste recovery services could help generate revenue to fund some aspects of the waste management system. A good system analysis and strategies in place for waste management in Kumasi could provide efficiency in the utilization of the available resources to cover most of the system costs while attracting grants and subsidies from the international donor community.

4.6. Socially acceptable strategies

Waste management system in the city of London is developed based on the support of the citizens. Proposed strategies for waste management are subject to public opinion. It can be seen in the document 'road map to maximize waste diversion in London' (City of London, 2007) that the citizen's views are sought and utilized in implementing waste management plans for the city. The citizen is at the centre of waste management in the city and it ensures that citizens and city authorities hold themselves accountable to waste management strategy adopted, which makes the system sustainable. Citizens of Kumasi should be made aware that they are accountable for the impact of their choices on how much waste they produce and how it will be managed. The communities should be involved in making decisions concerning waste management strategies. There should be a method of communicating waste management system performance and proposed strategies with the community in order to get feedback and support from the community. The communication system that best suits the public should be utilized.

4.7. Enactment and enforcement of legislation

Adequate legislation in place for the handling, treatment and disposal of all waste generated in the city of London has contributed positively to the development of the current integrated waste management system. The national, provincial and municipal legislation in place provides support for the waste management system in the city. The flexibility of the legislation, especially in the case of the city bye-laws, makes it possible for the legislation to be in consonance with the strategy accepted for waste management in the city in consultation with the citizenry. The sanctions for flouting the waste management bye-laws is clearly spelt out and implemented. This ensures compliance with the city's regulations concerning waste management. This is a good lesson that can be adopted in the city of Kumasi. As the bye-laws for waste handling the city are being reviewed, the structure can be made flexible with provision for periodic reviews to agree with the strategy for waste management in the city. The bye-laws must be made easily accessible or visible to all citizens to ensure that there are no excuses for non-compliance.

5. Conclusions

The significant strides made in achieving the current level of success in the city of London's waste management system is broadly due to the city's belief that a sustainable waste management system is based on sound guiding principles, strong service delivery values with as many locally based solutions as possible and moving at a fiscally responsive pace. This mindset is needed to move waste management in Kumasi and largely in developing countries towards achieving higher levels of sustainability. Any substantial change in the MSW management in Kumasi will require close cooperation between government, private sector and citizens. Although the city of London continues to draw up and implement strategies to meets its targets for achieving a high level of sustainability in its MSWM system, it serves as a good example to many cities as they aspire to see improvement in MSWM.

The resources and characteristics available for MSWM in London and Kumasi are obviously different as elaborated in the MSWM overview. The lessons that can be drawn from the MSWM features of the city of London to improve MSWM in Kumasi include:

I. Preparing a strategic, integrated solid waste management plan for the city. The plan should be drawn taking into account the waste generation sources, quantity, characteristics and the socio-economic and cultural structure of the city. In developing the plan, all possible stakeholders in the waste management system must be identified and brought together. Performance indicators should be agreed upon by all stakeholders and properly communicated to all parties to ensure that stakeholders feel part of the waste management system and are committed to its success. The plan should also consider financing schemes that will adequately pay for the cost of waste management and adoption of modes of payment that will be most effective considering all income groups in the city. This will require research and collaboration from all stakeholders. Intensive education of the inhabitants of the city is required to ensure they fully understand the health hazards posed by inadequate MSWM which will motivate them to pay for MSWM services.
II. Enacting strong and adequate legislation both from the national and city level to guide waste management decisions and strategies. To this end, there is the need for the enactment of a comprehensive national waste management law, backed by the requisite regulatory framework in terms of the bye-laws by the Kumasi Metropolitan Authority. These bye-laws should be made accessible (communicated sufficiently) to the inhabitants of the city to ensure no excuses for non-compliance.
III. Evaluating the real impacts of the waste management system. It will be good to measure the extent of pollution or environmental impacts associated with the existing waste management system to better appreciate the need for instituting adequate measures to prevent its occurrence.
IV. Taking steps to extend the lifespan of the cities landfill through waste diversion. Although Kumasi has a sanitary landfill, there is the need to divert waste from the landfill to increase its lifespan due to increasing waste generation and the increasing public opposition to siting MSWM facilities near their neighborhoods as citizens become more aware of the risks associated with MSWM facilities. As is seen from the situation in London, even though the landfill still has a possible life span of 20 years all efforts is being put in place to increase it through waste diversion. Attention could be paid to the activities of the informal sector involved in recycling activities in the cities and avenues sought to utilize their services and recognize their contribution to waste diversion and resource conservation.
V. Utilizing locally based solutions for MSWM service delivery. Locally based solutions should be sought for waste management equipment to ensure that they are serviced frequently and are in good condition at all times. This could reduce the investment needed for effective service delivery.

There is no single approach to waste management that makes it sustainable however the principles of integrated waste management could be followed to guide the development of site specific

MSW system that will be sustainable as demonstrated in the city of London. The good news is that Kumasi does not need to reinvent the wheel. All the requirements for sustainable waste management are documented in many other jurisdictions and can be easily transferred to Kumasi.

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