

Assessing '3Rs' Model in Relation to Municipal Solid Waste Management in Wa, Ghana

Kenneth Peprah*, Samuel Twumasi Amoah, Godwin Thomas Wedam Achana

Department of Environment and Resource Studies, University for Development Studies, Wa Campus, Ghana

Abstract Solid wastes are generated by human activities; the unavoidable outcomes of domestic and/or industrial production; and, exerting physical, social, economic and political effects on all sectors of society. The problem has to do with the quantum of solid waste generated and effective ways of management; while, the solution lies in the laid down policy or conceptual framework, configured as '3Rs' or 'RRR', that is, 'reduce, reuse and recycle'; in which, responsibility is spread across the individual, household members, production firms, municipal authorities and the private sector. The present paper assesses implementation of the '3Rs' policy directive in a deprived municipality in Ghana and draw on useful lessons for other municipalities exhibiting similar conditions. A little over eight years on since implementation started in 2006, individuals and households continue to handle solid waste as usual, the municipality has relinquished 80% of management responsibility to a private sector player; there are no pragmatic efforts to directly reduce the volume of solid waste; reuse and recycling are limited to collection of scrap metals and plastics. Sustainable development goals being drafted would have to consider north-south partnership, city management skills and technology transfer, if solid wastes are to be managed effectively in the emerging municipalities in Africa. Also, sister-city collaboration opens another avenue for assistance to the cities in the developing countries. The paper further concludes that, the '3Rs' model is a useful strategy for efficient and effective management of solid waste because it adheres to the tenets of achieving sustainable environment.

Keywords Solid waste, Reduction, Reuse, Recycling, Management, Wa

1. Introduction

Instead of a linear process, sustainable solid waste management uses a cyclical process, to manage waste today without jeopardizing the prospects of future generations [1]; a complete deviation from conventional waste management approaches towards waste management by seeking stakeholder participation [2]; and, with the purpose of ensuring environmental quality [3]. The new demand for sustainable solid waste management requires new paradigm [4]; configured as '3Rs' or 'RRR' in which the first 'R' stands for reduce, the next 'R' for reuse and the other 'R' for recycle [5, 6]. With regards to utilization, the '3Rs' could be used as policy tool and/or assessment/analytical tool. In the present paper, the '3Rs' represents policy directive of the government of Ghana; validation of which is sought in a deprived or emerging municipality in Upper West Region of Ghana.

According to Al-Maaded [6], the '3Rs' model provides the basis for a comprehensive management strategy of municipal solid waste; with the principal aim fashioned to

address health, environmental, aesthetic, land-use, resource and economic concerns associated with improper disposal of waste [7-9]. To Wu et al. [10] and Zaman [11], proper implementation of the '3Rs' strategy would engender conversion of solid wastes into new resources, reducing environmental pollution and optimizing natural resource utilization. Drawing on management tenets as involving responsibility, techniques, collective action, goals setting, activities to achieve the goals, procedures, maintenance as well as monitoring and evaluation [12], sustainable solid waste management revolves around stakeholder participation as including integrated and sustainable approaches to manage waste [13]; and, consensus building among households, service providers and users, community based organizations (CBOs), non-governmental organizations (NGOs), formal and informal private sector, local and central governments as well as external support agencies (ESAs) [13-15].

However, as revealed by [16], many waste producers shirk the responsibility of solid waste management; and, put the awesome burden on municipal authorities alone; resulting in progressively high cost of managing municipal solid waste; estimated at 20% - 50% of municipal budget [14]. Exacerbating the problem is the world's urban population increasing by two new people every second, and with 95 percent of such increases occurring in cities of developing

* Corresponding author:

primus146_2000@yahoo.com (Kenneth Peprah)

Published online at <http://journal.sapub.org/env>

Copyright © 2015 Scientific & Academic Publishing. All Rights Reserved

economies [17, 18]. As reported by Al-Maaded et al. [6], the fast-paced industrial growth, recent construction boom, increased population and urbanization, vastly improved life style and unsustainable consumption pattern have all contributed to the burgeoning municipal waste management problem. In Asia, day-to-day production of solid waste is about 760,000 tonnes [19]. About 25 million tonnes of solid waste is generated annually in Nigeria [20]. The rate of waste generation poses serious and disturbing threat to governments [21].

Driven by blight of uncollected solid waste in public places, smoke from burning of solid waste, the disgusting odor from decomposed waste, contamination of drinking water sources and outbreaks of diseases like cholera, the government of Ghana adopted the '3Rs' model to provide policy directives to municipal authorities to solve the solid waste menace; enjoying legal backing following the promulgation of the Local Government Act (Act 462) [22]. Providing further support to the '3Rs' policy tool, the national urban policy, *inter alia* entreats municipal assemblies to deal specifically with:

- mapping of the sources of waste in the municipalities,
- regular evaluation of waste producers,
- choice of waste management technology and engineering options,
- creation and use of landfill,
- observance of Environmental Protection Agency guidelines on landfill,
- public education on waste management through various campaigns,
- capacity enhancement of municipal authorities in waste management,
- involvement of the private sector in the provision of sanitation, and,
- enforcement of legislation on waste management.

Table 1 summarizes roles and linkages of stakeholders in solid waste management in Ghana. The major stakeholders:

Metropolitan, Municipal, District and Agencies (MMDAs), Private sector players, particularly, Zoomlion Ghana Limited and waste producers interact in daily tasks generating, collecting, disposing waste; and, playing out various relationships.

2. Literature Review

Solid waste management is understood as supervised handling of waste materials from source through recovery processes to disposal [1]; and, it involves control of generation, storage, collection, transportation, processing and disposal of solid waste with the aim of protecting environmental quality, human health and preservation of natural resources [27, 28]. In addition, solid waste refers to non-liquid material that is no longer valuable to the owner as including rubbish, garbage, trash, or refuse [29]; examples include kitchen waste, paper products, rags, plastics, rubber, leather, bone, glass, crockery, pots, sweepings, metal and old furniture [30] as generated by households, offices, hotels, shopping complexes/shops, markets, yards, schools, institutions and street cleaning [31]; categorized as household/domestic, commercial, institutional, industrial and agricultural waste [13, 32:21]; and, excluding semisolid waste such as sludge and night-soil (liquid waste) and clinical waste produced by hospitals [14].

As argued by Al-Maaded [6], solid waste management which is done along the lines of a systematic utilization of reducing, reusing and recycling depends on managerial procedures, practical choices and state-of-the-art strategies. Lenox and King [33] found that effective reduction, reusing and recycling of waste are achieved with the support of relevant equipment and use of experienced personnel; the reverse is true, lack of equipment for waste crushing or refining processes derails the process [34]; while, inexperience personnel decreases the success rate [35].

Table 1. Existing solid waste management system in Ghana

Stakeholders	Roles or Duties	Linkages	References
Metropolitan, Municipal, District and Agencies	Waste collection and management by local governments	Employed private sector waste companies, educate and legislate activities of waste producers. However, the engagement of Zoomlion Ghana Limited was carried out by the central government.	[23] [24]
Private sector players, particularly, Zoomlion Ghana Limited	Provides improved waste services, employment, in-service training, knowledge exchange programmes, door-to-door solid waste collection, free waste bins; street and pavement sweeping; and, central communal solid waste collection	Ensure environmental quality resulting in good health, incomes accruing from employment and the main link between MMDAs and waste producers	[25] [26]
Waste producers	Waste generation and disposal in dust bins/trash cans and dumpster	Beneficiaries of proper sanitary conditions or otherwise. There is poor linkage between Zoomlion Ghana Limited and waste producers	[24]

Source: Field work (2015)

As an elaboration, the '3Rs' model is considered as state-of-the-art philosophy of waste management [29]. In [29 citing, 36], the 3-tier-R has been expanded into six hierarchical steps: prevention, reduction, reuse, recycle, energy recovery and disposal. For the municipal waste managers, a comprehensive understanding of the '3Rs' model is critical [15]. Used as conservation approach, the emphasis is laid on reduction, reusing and recycling of bio-degradable and non-biodegradable waste [37]; and, providing an environmentally friendly option to manage waste [38]. Upon completion of the '3Rs' processes, the maximum benefit is minimization of waste volume [21, 39, 40], decline in the reliance on landfills, decrease in the environmental costs associated with management, and improvement in serious public health concerns [41, 42]. In addition, some landfills or incinerators recover energy efficiently [23]. Hence, in siting of landfills the 'don't' should entail the avoidance of environmentally sensitive areas such as: wetlands, floodplains, drinking water sources, fault lines and within 2 km of airport; while, the 'do' embraces areas on top of clay or igneous rock, sufficiently large land and with community participation [43].

The first R (reduce) involves prevention and reduction of waste. To reduce waste means to minimize amount of waste generated. Waste reduction could be achieved through legislation, product design, local programmes to keep recyclables and compostables from the waste [38]. Waste reduction stresses upon judicious use of resources in manufacturing. Legislation compels a manufacturer to maintain particular standards in designing products or limit production activity as happens in Europe and USA [38, 44]. Also, separation of waste at source achieves the same goal of waste reduction; intensified by public awareness and education. For instance, India uses student rallies and public meetings as campaign strategies to propagate waste segregation and reduction [29].

The second R (reuse) involves secondary and subsequent uses of waste materials either in part or whole. Reuse of waste is exemplified by trade in second-hand goods: cloths, electronics, automobiles, furniture and other merchandise [44:2]. 'Reuse' is achieved through sorting done at source rather than disposal site [43]; and, through detailed processes of checking, cleaning, refurbishing, repairing whole items or spare parts [23:2].

The third R (recycle) depends on waste materials which cannot be reused directly but can be converted to new product or raw material through the processes of transformation [38]. For instance, used paper is recycled into files, envelopes and cards [15]. Energy is recovered through recycling through: pyrolysis (combustion of waste in the absence of oxygen to create gases, liquids and solid compounds), incineration (combustion in the presence of oxygen to produce oxidized compounds), anaerobic digestion, gasification and pelletization [23, 29]; as well as composting (biological and chemical degradation of organic waste in either large centralized, small enterprise, backyard or household basis) [43].

Together, the '3Rs' aimed at achieving sustainable solid waste management; and, also relates to other global environmental challenges, particularly, climate change mitigation, specifically, the emission of greenhouse gases that could create sustainable development co-benefits and reduction in the emissions of methane (CH₄), biogenic carbon dioxide (CO₂), non-methane volatile organic compounds (NMVOCs), nitrous oxide (N₂O), nitrogen oxide (NO_x) and carbon monoxide (CO) from landfills [34, 45]. Technologies required to reduce or eliminate greenhouse gases emission, sustainable though, include composting of organic waste, high-tech incineration and expanded sanitation coverage, industrial co-combustion for waste-to-energy, landfill gas recovery as well as thermal processes for waste-to-energy [1]. For example, in Europe landfill receives 66% of waste, incinerated (18%), composted (6%) and recycled (10%); in Eastern Europe, landfill takes 90% and recycled (10%) [36]. In the USA, recycling, for instance, takes care of cans, bottles, shipping cardboard, unsold food and scrap [44].

In dealing with the cost of sustainable solid waste management, different principles have been developed: extended product responsibility in which waste disposal cost is inputted in the market price of the product [21] and the polluter pays principle [36].

Success story of sustainable solid waste management is reported in [15]; a case study in Nepal with European Union funding; involving activities such as expansion of house-to-house waste collection, employment generation for community members for street sweeping, and, addition of 58 new dumpsters; installation of organic waste compost machine at Bhaktapur; creation of landfill at Katuwu Khola which replaces dumping of municipal waste at the river bank; and, public private partnership in waste management in Biratnagar with success in only one of the three companies. Main benefits include sale of compost from recycled waste and employment sourced from the three waste management companies. In Hetauda, success is augmented by the involvement of CBOs and NGOs.

3. Materials and Methods

The dynamics of the study area, Wa Municipal, geographically located on the confluence of latitudes 1°40"N to 2°45"N and longitudes 9°32' to 10°20'W; spreading over land surface of 234.74 km² [46] in a semi-arid region; resonate the interplay of temperature and rainfall on waste degradability. With six months of rainfall, there is the possibility of surface and ground water pollution; increase in greenhouse gases emission of wet waste; and, the remaining six dry months, lack of water may reduce biodegradable activity [47]. With a total population of 13,740 in 1970 and 36,067 in 1984, the city now has a population of 71,083 and a growth rate of 4% per annum [48].

Evidence of largely unsustainable waste management abounds in Wa. According to [49] only 27% (216 tonnes) of solid waste are collected, while, the remaining 73% (594

tonnes) poses environmental and health hazards. Against the backdrop of huge uncollected waste deficit, [24, 50] found Zoomlion Ghana Limited-Wa, seriously under resourced to manage solid waste effectively; and, the main challenge being lack of experienced personnel and relevant equipment [51].

The study design employed a purely qualitative approach with the support of desk study of literature. There was heavy reliance on primary data generated from three sources: Wa Municipal Sanitation Department, Zoomlion Ghana Limited-Wa and Siriyiri community members. Data collection techniques included in-depth interview, focus group discuss and a tabular questionnaire scheme for the two institutions as well as transect walk at the solid waste dump site near Siriyiri for personal observation. Secondary data was provided by the Judicial Service, Wa.

4. Results

Table 2 summarizes current waste management activities and plans for the future. In the interim, the municipal authorities tend to rely on legislation and enforcement to reduce waste; placing greater emphasis on sanitation towards the achievement of environmental quality and public health. In the near future, plans are afoot to collect great amount of solid waste through provision of waste bins. Both the present and future activities may be deemed worrisome with regard to 'reducing solid waste' because waste collection efficiency instead of reduction may be the likely outcome. In the context of 'reuse of solid waste', much attention is devoted to handling plastic waste menace through public education stressing on disposal of sachet water plastic bags; and, incentives (income) accruing from gathering the sachet for re-sale. The municipal assembly relies on the capacity of Zoomlion Ghana Limited-Wa for recycling of waste; the capacity which is currently non-existing. Presently, Wa municipal has relinquished 80% responsibility of waste management to Zoomlion Ghana Limited-Wa.

Table 2. Activities of Wa Municipal Assembly on Reducing, Re-using and Recycling of Solid Waste

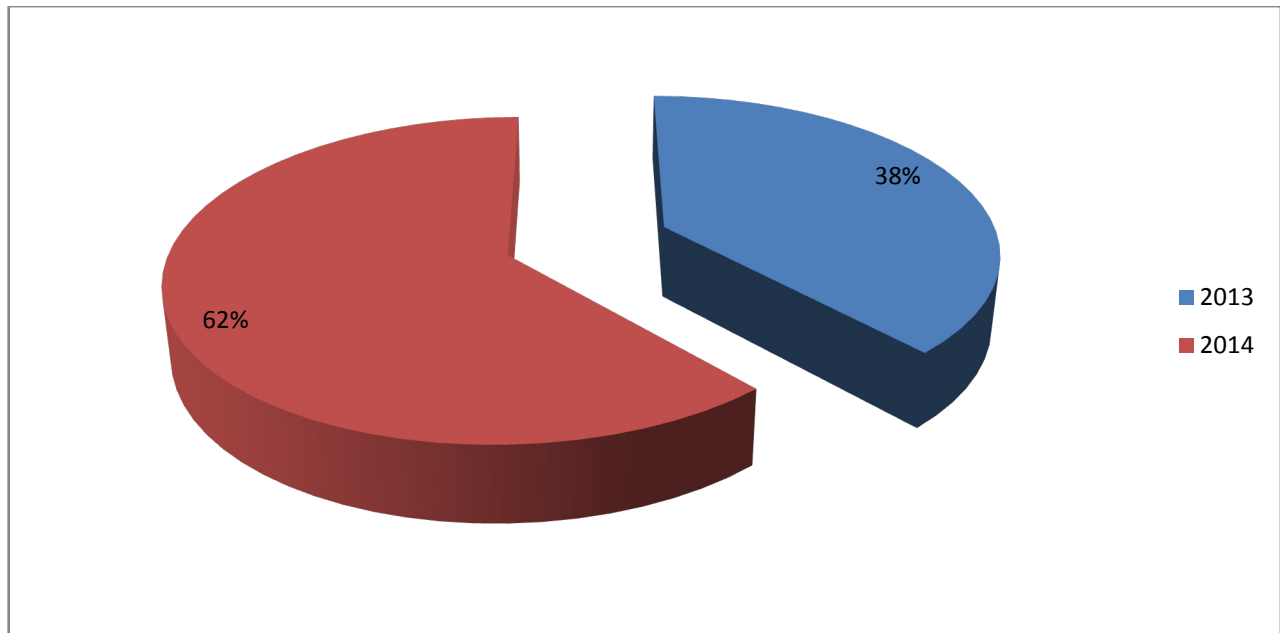
3Rs	Current State	Future Plan
Reducing Solid Waste	Prosecution of offenders of sanitation by-laws by the Sanitation Department	The Assembly is trying to increase waste bins for the collection of solid waste
Reusing Solid Waste	The Assembly and the Environmental Health Department are educating people to collect and bring plastic waste for bung and to be sent to Kumasi for recycling	Re-using of plastics particularly sachet water bags (locally known as ice water rubber)
Recycling Solid Waste	Education by the Assembly and the Environmental Health Department	Collaboration with Zoomlion Ghana Limited to set up recycling plant in Wa

Source: Field work (2015)

Table 3. Activities of Zoomlion Ghana Limited on Reducing, Re-using and Recycling of Solid Waste

3Rs	Current State	Future Plan
Reducing Solid Waste	Radio and other public education to reduce the use of plastics especially as food vending wrappers	To educate people about how to reduce solid waste at homes
	Bulk collection of solid waste, transportation and dumping on a piece of land at the outskirts	To separate solid waste at source into plastics, paper, bottles, etc.
	Solid wastes collected are not compressed	Creation of collection points to compress volumes of solid waste into smaller volumes and send to the 'landfill' (Transfer stations)
	Dumpsters and waste bins for communal and domestic solid waste collection	Stop indiscriminate solid waste disposal
Re-using Solid Waste	Currently, the company is not doing re-using but some individuals do	Collection of plastic related products for storage purposes
	Obsolete tricycles and other unused metals are sold to scrap dealers	Picking of metals as scrap for the steel industries
	No composting at Wa as happens in Accra and Tamale	Sorting of degradable materials for compost – fertilizer
Recycling Solid Waste	Gathering of plastics in the communities and grinding same into pellets (intended). The plant/machine for the grinding ready for installation at Wa.	Sorting of plastics for recycling

Source: Field work (2015)



Source: Judicial Service Wa (2015)

Figure 1. Sanitation court cases for 2013-2014

Table 3 captures present and planned activities of Zoomlion Ghana Limited-Wa in '3Rs' implementation. Current activities are geared towards achievement of efficiency in waste collection, while, the company plans to introduce waste separation at source, and, waste compression at communal collection centers as a way of reducing solid waste. At present, solid waste reusing in all forms is pending; planned intentions include gathering and creation of large plastic storage as raw material, generation of scrap metal for re-sale and manufacturing of compost. Due to the enormity of plastic waste menace, present and future activities in recycling places much emphasis of plastics to the neglect of other types of waste for possible recycling.

Figure 1 shows increasing number of court cases in 2014 over 2013; there were 33 charged cases in all; more than half of the cases occurred in 2014 (62%); and, sanctions ranging from GH¢200.00.

5. Discussion

Overall, the study illustrates that, the first R, reduction of solid waste relates to the efficient minimization of solid waste production, waste prevention and diversion from the waste stream; leaving little solid waste for dumping at the landfill site [52]. Presently, high class residential areas in the city patronize the door to door service that is provided by Zoomlion Ghana Limited at a monthly fee of Twenty Ghana Cedis (GH¢20) (Equivalent to US\$ 6.6). Per the service contract, the company is required to collect, transport and dispose waste at a dumping site once every week [53]. The once weekly collection also coincides with the findings of [53-55]. One of the most striking findings of the study is that, all kinds of solids are dumped in the bins when declared unwanted by the households and institutions; and, there is no

separation of solid waste at source. When the dumpster is full of waste, the unsorted load is tipped at the dumping near Siriyiri, a large piece of land fenced for the purpose. The dumping of solid waste into communal containers (mostly placed near public toilet facilities - known as Kumasi Ventilated Improved Pits – KVIPs) remained the common option for domestic solid waste disposal in most low-income households in Wa. These communal containers are provided by both the Municipal Assembly and Zoomlion Ghana Limited. Collection of these communal containers is irregular, which leaves the urban space filled with heaps of uncollected solid wastes especially in the ill-served low income suburbs. The conventional practices of solid waste generation and disposal become twofold environmental issues very critical across the globe as argued by [55] and a departure from the tenets of the '3Rs', particularly, waste reduction. Suffice to say that this situation attracts disease-carrying pests and creating grounds for serious public and environmental health hazards as posited by [53, 56]. When full, towing vehicle lift the metal bins and empty the content at the dumping site. Presently, there is no strategy in place to reduce the generation of solid wastes at source. There is also no sorting of solid waste either at the central communal collection or dumping site. Hence, no specific measure is taken by the Municipal Assembly or Zoomlion Ghana Limited-Wa, to directly reduce the volume of solid waste so far as the first R is concerned.

The second R, reusing of solid waste involves the principle of 'used ones as substitutes', considering solid waste as 'treasure not trash' and/or 'resource not refuse' [57]. Currently, reusing of solid waste is not quite popular in the municipality. Sachet water plastics are seen collected for sale; intended to be transported from Wa to Kumasi for reuse. Some scavengers were found at the dumping site combing

the waste for reuse materials. Such activities are considered illegal by the municipal assembly and are carried out at the blind sight. The reuse of solid waste also resonates with the findings of [5] that ‘to redeem the value of waste, either by reintegrating it with the production system somehow, or by recognizing the use value of certain objects’. Illegally, some farmers collect solid waste from the dumping site and use it in the farm to improve upon soil fertility. The most classic example of reuse is provided by the reuse of plastic bottles, mainly, drinking water and coca cola bottles. Due to the progressively warm weather, people attending meetings and durbars are re-hydrated with water and non-alcoholic drinks. Women and children throng meeting venues and durbar grounds to collect plastic bottles either for re-sale or direct usage for packaging locally made non-alcoholic drink, the very popular “*sobolo*” drink. The foregoing findings reiterate the argument made by contemporary scholars on waste [5, 18, 58, 59, 60] that developing countries need to rethink waste as a resource (reuse of waste).

The third R, recycling of solid waste into new products is happening on a small scale. The recycling of metal scrap was common among the blacksmith in the Municipality to manufacture simple tools such as hoes, pick axe, coal pots for cooking, “gong”, hammers and knives. Electrical welders also depend on scrap metals for the making of metal doors, gates and beds. Others gather the scrap metals for re-sale for onward transportation to Tema for the manufacture of iron rods in the construction industry. Although Zoomlion Ghana Limited has the capacity to produce compost – fertilizer from municipal solid waste in Accra and Tamale, the Wa Office lacks such capacity. During the group discussion, indigenous farmers expressed interest in the use of untreated solid waste to boost soil fertility. Hence, compost – fertilizer will be patronized by farmers contingent upon pricing.

The study also sought to assess the compliance level of sanitation by-laws in the municipality. It was revealed that the common offences included: accumulation of refuse in the homes, indiscriminate disposal of bath waste water, insanitary drainage systems for bath waste water (behind bathrooms), garbage littered surroundings, over grown weeds, food vending without medical certification, operating a business without refuse bin and obstruction to duty of sanitary inspectors. Offenders are summoned before the law court and usually fined various sums of money depending on the kind of offence committed. Furthermore, study revealed that neither the Wa Municipal Assembly nor Zoomlion Ghana Limited-Wa is currently running any educational or informative programme on sanitation on radio or television.

6. Conclusions

The study aimed at validating the use of ‘3Rs’ policy tool or conceptual framework for sustainable municipal solid waste management in Wa Municipal Assembly (WMA) in compliance with the national directive enshrined in the national urban policy which enjoins MMDAs to practice

reducing, reusing and recycling of solid waste. Implementation started in 2006; evidence on the ground shows that collaborative work between Wa Municipal Assembly and Zoomlion Ghana Limited are effective in solid waste collection and disposal at a designated dumping site. In terms of the first R, reducing, there is currently no strategy in place to reduce solid waste at any point in the management chain. Solid waste is not reduced in any form; it is a matter of collection and disposal. The second R, reusing, is done at the individual residents’ level, particularly, for scrap metal and plastic bottles. Plastics from sachet water are collected by individuals for re-sale. Neither the Assembly nor Zoomlion Ghana Limited-Wa reuses municipal solid waste in any form. The third R, recycling, is dependent on machinery and technology, although, Zoomlion Ghana Limited has the logistics and personnel at the national level, Wa municipal lacks the requisite logistics to do any recycling of solid waste into new products. Even though, compost – fertilizer a product of Zoomlion Ghana Limited-Wa could be of immense benefit to indigenous farmers, Zoomlion Ghana Limited in Wa municipality lacks the resources for recycling municipal solid waste into compost – fertilizer. In the proper management of municipal solid waste, the application of the ‘3Rs’ – ‘reducing, reusing and recycling’ are very prominent for successful implementation of solid waste management. Until now, the partnership of Wa Municipal Assembly and Zoomlion Ghana Limited-Wa remains at the level of collection and disposal of municipal solid waste. It is important to state that the ‘3Rs’ policy directive by the government of Ghana is yet to be actualized in Wa Municipal.

The ‘3Rs’ either as a policy tool or conceptual model is quiet technical; successful implementation in the emerging cities in the south, particularly, Wa in Ghana, require managerial skills, state-of-the-art strategies and equipment as well as experienced technical personnel; a direct approach to enhance success is international assistance that could be derived from sister-city initiative, while, an indirect approach could be sought through international policy directive which could be provided by the sustainable development goals, especially, goal 6, target 6.2.

7. Lessons and Recommendations

- With the increasing urbanization of major towns in Ghana, particularly, regional capitals, replication of Zoomlion Ghana Limited Accra branch in the remaining regional capitals is imperative. However, the practical steps to implement the ‘3Rs’ framework is the major trajectory in achieving sustainable municipal solid waste management. In so doing, existing partnership between government (MMDAs) and Zoomlion Ghana Limited should be improved for smooth implementation of the ‘3Rs’ model of sustainable municipal solid waste management.
- Following about eight years of implementation of ‘3Rs’

policy tool in Wa municipal, solid waste management, continues to operate on the 'business as usual' basis. Drawing on the Nepal success story, north-south collaboration with funding and technology transfer from the north (e.g. EU) is imperative to success. Hence, the draft sustainable development goal 6 should address this concern.

“Goal 6. Ensure availability and sustainable management of water and sanitation for all - 6.2 by 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations”.

- Considering the management style and skills of the Wa Municipal authorities, any other city that exhibits similar features will require a move from a vicious circle to function on a virtuous circle only with a massive support from developed cities in the north in terms of management skills' transfers. In this direction, sister-city projects of finding counterpart cities in the south and north hold positive prospects. Although, Wa-Leper City (Belgium) partnership started in 2002, generated a manufacturing fruit factory in Wa in 2003, other collaborative benefits, particularly, on sanitation has not yet materialize.
- In addressing the issues of lack of experienced personnel, essentially, at the municipal assembly, Ghana and other developing countries, could revert to the pre-independence good practice in which district commissioners (DCs) were mainly engineers from the UK; presently municipal district chief executives (DCEs) could be selected from special professionals with PhD level of education or equivalent as such specialized professional expertise would be brought to bear on the challenges that confronts the district assemblies.
- In view of the indiscriminate solid waste disposal and lack of separation of solid waste at source at Wa Municipal and other cities that demonstrate comparable characteristics, the need for an overt programme of action to address attitudes, behaviours and choices of the citizenry is recommended to the municipal authorities.

REFERENCES

- [1] J. Chirico, There is No Such Thing as "Away": An Analysis of Sustainable Solid Waste Management Technologies School of Public Policy Enterprise Innovation Institute Science, Technology, and Innovation Policy Program Georgia Institute of Technology, Atlanta Georgia, 2009, pp. 1-60.
- [2] A. van de Klundert, The Sustainability of Alliances between Stakeholders in Waste Management. Working paper for UWEP/CWG Netherlands Ministry for Development Co-operation (2000) 1-22.
- [3] B. Abila, and J. Kantola, Municipal Solid Waste Management Problems in Nigeria: Evolving Knowledge Management Solution International Journal of Environmental, Ecological, Geological and Geophysical Engineering 7 (2013) 172-177.
- [4] B.A. Gani, A. Chiroma, and B.A. Gana, Women and Solid Waste Segregation in Bauchi Nigeria. Journal of Environment and Earth Science 2 (2012) 25-45.
- [5] S.A. Moore, Garbage Matters: Concepts in New Geographies of Waste. Progress in Human Geography 36 (2012) 780-799.
- [6] M. Al-Maaded, N.M. Madi, R. Kahraman, A. Hodzic, and N.G. Ozerkan, An Overview of Solid Waste Management and Plastic Recycling in Qatar. J Polym Environ 20 (2012) 186-194.
- [7] R.K. Henry, Z. Yongsheng, and D. Jun, Municipal Solid Waste Management Challenges in Developing Countries - Kenyan Case Study. Waste Management 26 (2006) 92-100.
- [8] N.L. Nemerow, Environmental Engineering: Environmental Health and Safety for Municipal Infrastructure, Land Use and Planning, and Industry, Wiley, Hoboken, N. J., 2009.
- [9] D.C. Wilson, Development Divers for Waste Management. Waste Management & Research 25 (2007) 198-207.
- [10] H.-Q. Wu, Y. Shia, and Q. Xiaa, Effectiveness of the Policy of Circular Economy in China: A DEA-Based Analysis for the Period of 11th Five Year - Plan. Resources, Conservation and Recycling 83 (2014) 163- 175.
- [11] A.U. Zaman, Identification of Key Assessment Indicators of the Zero Waste Management Systems. Ecological Indicators 36 (2014) 682- 693.
- [12] Geddes and Grosset, Webster's Reference Library Concise Edition English Dictionary, Geddes and Grosset, New Lanark, 1999.
- [13] UNEP, Global Partnership on Waste Management: Integrated Solid Waste Management (ISWM) Work Plan for 2012-2013, United Nations Environmental Programme, Nairobi, 2011, pp. 1-17.
- [14] P. Schubeler, K. Wehrle, and J. Christen, Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries, Urban Management and Infrastructure, UNDP/UNCHS/WORLD BANK-UMP, St Gallen Switzerland, 1996, pp. 1-59.
- [15] Practical Action Nepal, Best Practices in Waste Management in Napeles Cities, Practical Action Nepal, Kathmandu, 2008, pp. 1-59.
- [16] G. Burke, R.B. Singh, and L. Theodore, Handbook of Environmental Management and Technology, Wiley and Son, Canada, 2000.
- [17] D. Hoornweg, and B.-T. Perinaz, What a Waste: A Global Review of Solid Waste Management, World Bank, Washington DC 2012.
- [18] M. Oteng-Ababio, Rethinking Waste as a Resource: Insights from a Low-Income Community in Accra, Ghana. City, Territory and Architecture (2014) 1:10.
- [19] World Bank, What A Waste: Solid Waste Management in Asia, The International Bank for Reconstruction and Development/The World Bank, Washington D. C., 1999, pp. 1-45.

- [20] T.C. Ogwueleka, Municipal Solid Waste Characteristics and Management in Nigeria. *Iran. J. Environ. Health Sci. Eng.* 6 (2009) 173-180.
- [21] P.O. Magutu, and C.O. Onsongo, Operationalising Municipal Solid Waste Management. in: S. Kumar, (Ed.), *Integrated Waste Management - Volume II*, In Tech, Shanghai, 2011.
- [22] MLGRD, Ghana National Urban Policy: Action Plan, Ministry of Local Government and Rural Development, Accra, 2012, pp. 1-50.
- [23] L. Fewtrell, Municipal Solid Waste and Health, Research Report for Regional Visions of Integrated Sustainable Infrastructure Optimised for Neighbourhoods (ReVISIONS), CREH, Aberystwyth University 2012, pp. 1-31.
- [24] P.A. Bowan, Urban Solid Waste Management in Ghana: an Assessment of Zoomlion's Approach to Waste Management in the Wa Municipality *Journal of Environment and Earth Science* 3 (2013) 73-79.
- [25] B.E. Asare, and M.K. Frimpong, Public-Private Partnerships and Urban Sanitation: Do Expectations Meet Realities in Madina-Ghana? *Journal of African Studies and Development* 5 (2013) 113-124.
- [26] M.A. Akaateba, and I. Yakubu, Householders' Satisfaction Towards Solid Waste Collection Services of Zoomlion Ghana Limited in Wa, Ghana. *European Scientific Journal* 9 (2013) 198-213.
- [27] E. Daskalopoulos, O. Badr, and S.D. Probert, Economic and Environmental Evaluations of Waste Treatment and Disposal Technologies for Municipal Solid Waste. *Appl Ecol* 58 (1999) 2009-2055.
- [28] Y.P. Lin, H. Huang, W. Lu, and L. He, Modeling of Substrate Degradation and Oxygen Consumption in Waste Composting Processes. *Waste Manag.* 28 (2008) 1375-1385.
- [29] D. Zhu, P.U. Asnani, C. Zurbrugg, S. Anapolsky, and S. Mani, Improving Municipal Solid Waste Management in India: A Sourcebook for Policy Makers and Practitioners, The International Bank for Reconstruction and Development/ The World Bank, Washington, D. C., 2008.
- [30] S.M. Shakya, and B. Tuladhar, State of Municipal Solid Waste Management in the Municipalities of Nepal. in: Pariatamby A., and M. Tanaka, (Eds.), *Municipal Solid Waste Management in Asia and the Pacific Islands*, Environmental Science and Engineering, Springer, Pacific Islands, 2014, pp. 233-254.
- [31] G. Borongan, and S. Okumura, Municipal Solid Waste Management Report: Status-quo and Issues in Southeast and East Asian Countries, AIT/UNEP, Japan, 2010, pp. 1-52.
- [32] UNCED, Agenda 21: Environmentally Sound Management of Solid Wastes and Sewage-Related Issues, United Nations Conference on Environment and Development, United Nations Organizations, Rio de Janeiro, Brazil, 1992.
- [33] M. Lenox, and A. King, Prospects for Developing Absorptive Capacity through Internal Information Provision. *Strategic Management Journal* 25 (2004) 331-345.
- [34] J. Field, and R. Sroufe, The Use of Recycled Materials in Manufacturing: Implications for Supply Chain Management and Operations Strategy. *International Journal of Production Research* 45 (2007) 4439-4463.
- [35] M. Lapre, A. Mukherjee, and L. Van Wassenhove, Behind the Learning Curve: Linking Learning Activities to Waste Reduction. *Management Science* 46 (2000) 597-611.
- [36] EU, The Impact of Community Environmental Waste Policies on Economic and Social Cohesion, European Union, Brussels, 2001, pp. 1-43.
- [37] I.O. Ogunrinola, and A.E. Omosalewa, Health and Economic Implications of Waste Dumpsites in Cities: The Case of Lagos, Nigeria. *International Journal of Economics and Finance* 4 (2012) 239-251.
- [38] Crown, Guidance on the Legal Definition of Waste and Its Application, Department for Environment, Food and Rural Affairs, London, 2012, pp. 1-69.
- [39] S.A. Moore, The Excess of Modernity: Garbage Politics in Oaxaca, Mexico. *Professional Geographer* 61 (2009) 426-437.
- [40] S.A. Moore, Global Garbage: Waste, Trash Trading, and Local Garbage Politics. in: R. Peet, P. Robbins, and M. Watts, (Eds.), *Global Political Ecology*, Routledge, Abingdon, 2011, pp. 133-144.
- [41] J.N. Fobil, N.A. Armah, J.N. Hogarh, and D. Carboo, The Influence of Institutions and oOrganisations on Urban Waste Collection Systems: An Analysis of Waste Collection System in Accra. *Journal of Environmental Management* 86 (2008) 262-271.
- [42] G. Owusu, M. Oteng-Ababio, and R.L. Afutu-Kotey, Conflicts and Governance of Landfills in a Developing Country City, Accra. *Landscape and Urban Planning* 104 (2012) 105-113.
- [43] The Cadmus Group, Solid Waste: Generation, Handling, Treatment and Disposal, Solid Waste, Environmental Guidelines for Small-Scale Activities in Africa (EGSSAA), USA, 2009, pp. 1-29.
- [44] G. Goldman, and A. Ogishi, The Economic Impact of Waste Disposal and Diversion in California: A Report to the California Integrated Waste Management Board, University of California, Berkeley, California, 2001, pp. 1-105.
- [45] R. Pipatti, P. Svardal, J.W.S. Alves, Q. Qingxian Gao, C.L. Carlos López Cabrera, K. Katarina Mareckova, H. Oonk, E. Scheehle, C. Sharma, A. Alison Smith, and M. Yamada, Solid Waste Disposal, IPCC Guidelines for National Greenhouse Gas Inventories, IPCC, Japan, 2006.
- [46] M.S. Aduah, and R. Aabeyir, Land Cover Dynamics of Wa Municipality, Upper West Region of Ghana. *Research Journal of Environmental and Earth Sciences* 4 (2012) 658-664 <http://maxwellsci.com/print/rjees/v4-658-664.pdf>.
- [47] M. Aljaradin, and K.M. Persson, Environmental Impact of Municipal Solid Waste Landfills in Semi-Arid Climates - Case Study - Jordan *The Open Waste Management Journal* 5 (2012) 28-39.
- [48] GSS, Final Report on Population and Housing Census, Ghana Statistical Service: Sakoa Press Limited Accra, 2012.
- [49] A.S. Twumasi, and E.A. Kosoe, Solid Waste Management in Urban Areas of Ghana: Issues and Experiences from Wa.

- Journal of Environment Pollution and Human Health 2 (2014) 110-117.
- [50] A.-K. Yahaya, and E. Owusu-Sekyere, Challenges of Privatizing Waste Management in the in Wa Municipality Of Ghana: A Case of Zoomlion Ghana Limited Journal of Environment and Earth Science 2 (2012) 68-79.
- [51] P.A. Bowan, Private Sector Capacity in the Management of Urban Solid Waste in Ghana – A Study of Zoomlion in the Wa Municipality. Journal of Studies in Social Sciences 5 (2013) 352-364.
- [52] T.V. Ramachandra, Integrated Management of Municipal Solid Waste. in: S.R. Garg, (Ed.), Environmental Security: Human and Animal Health, IBDC Publishers, India, 2011.
- [53] S.T. Amoah, and E.A. Kosoe, Solid Waste Management in Urban Areas of Ghana: Issues and Experiences from Wa. Journal of Environment Pollution and Human Health 2 (2014) 110-117.
- [54] N. Obirih-Opareh, and J. Post, Quality Assessment of Public and Private Modes of Solid Waste Collection in Accra, Ghana. Habitat International 26 (2002) 95-112.
- [55] A.M. Hilburn, Participatory Risk Mapping Of Garbage-Related Issues In A Rural Mexican Municipality. Geographical Review 105 (2015) 41-60.
- [56] M. Oteng-Ababio, J.E. Melara, and O. Gabbay, Solid Waste Management in African Cities: Sorting the Facts from the Fads in Accra, Ghana. Habitat Int'l 39 (2012) 96-104.
- [57] F. Abdul-Rahman, Reduce, Reuse, Recycle: Alternatives for Waste Management. Guide G-314 (2014) 1-4.
- [58] F.M.A. Harris, Farm-level assessment of the nutrient balance in northern Nigeria. Agriculture Ecosystems and Environment 71 (1998) 201-214.
- [59] B.H. Janssen, and O. Oenema, Global Economics of Nutrient Cycling. Turkish Journal of Agriculture and Forestry 32 (2008) 165-176.
- [60] D. Matless, Bodies Made of Grass Made of Earth Made of Bodies: Organicism, Diet and National Health in Mid-Twentieth-Century England. Journal of Historical Geography 27 (2001) 355-376.