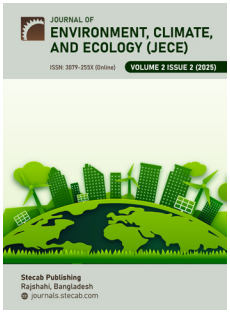

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Research Article

Public Engagement in Solid Waste Management: An Evaluation Analysis of Techiman Municipal of Ghana

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About Article

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ABSTRACT

Waste collection and disposal are a major challenge for many District, Municipal, and Metropolitan Assemblies in Ghana due to rapid economic and population growth. Techiman Municipality and, for that matter, Techiman Township, is no exception. Currently, all the waste generated ends up at the final disposal site without the retrieval of useful materials. This study was the culmination of research carried out to investigate the level of public participation in solid waste management by assessing physical composition and per capita waste generated, as well as the current practice of the public towards municipal waste management. Questionnaire survey and interviews with key stakeholders were also carried out. The results show solid waste composition of 57% biodegradables and 42.5% non-biodegradables. The average per capita waste generated was 0.70 kg/capita/day. The study further revealed that 30% of the respondents were aware of the existence of a dump site in the Techiman Municipality. The public engagement in solid waste management includes waste collection, sorting of waste, transportation, and recycling. Other potential roles of the public identified include the reuse of waste, composting, and waste separation. It is recommended that active participation and public sensitization in solid waste management be carried out through mass education on radio, television, newspapers, and other media.

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1. INTRODUCTION

Municipal solid waste (MSW), commonly known as trash, garbage, or rubbish, is a type of waste consisting of everyday items that are discarded by the public. Solid waste management (SWM) is essential because it curbs and decreases both urban and rural pollution (Chen *et al*., 2010; Tian *et al*., 2013). Tian *et al*. (2013) asserted that diverse SWM in China culminated in a variance in the atmospheric air pollution characteristics. Also, SWM stimulates safe and healthy human surroundings as well as bolsters sustainable economic development. Waste disposal problems are attributed to the upsurge of economic growth, uncontrolled and unmonitored urbanization due to industrialization (UNEP, 2007). The problem is further compounded by inadequate inclusion of waste generators (i.e., the public), coupled with inadequate financial resources, limited trained personnel in solid waste management procedures, specifically in the areas of garbage gathering, equipment for processing, and the actual dumping of waste materials. Therefore, waste collection agents and agencies are saddled with the challenge of inappropriate management procedures. Public participation constitutes an essential element of any development milestone in the public domain. In many countries, communities are often regarded as mere beneficiaries of government services and are not considered to take part in decision-making processes concerning them (Joardar, 2006). One of the disadvantages of the foregoing approach is the underestimation of the role of the citizens in the development-related endeavors. Thus, the merits of public participation in the SWM cannot be gainsaid. Previous researchers have focused on community engagement in the SWM, such as recycling of garbage (Barr, 2004). The findings of such studies corroborate the urgent need for waste generators to actively take part in the SWM systems. The scarcity of landfill sites in communities and the unwillingness to accept the location of garbage dumps in most communities are based on health and environmental grounds (Barr, 2004). The public participation in the SWM process is appropriate considering the dictatorial nature of the status quo (transfer of a policy to the communities). Of critical importance are problems emanating from the SWM in the urban areas. Rural and urban folks are saddled with waste management problems. Human beings are not only susceptible but also contributors of waste in diverse ways (Chen *et al*., 2010). The making of waste, the nature/type of waste generated, is contingent on diverse factors. Evidence-based research posits that more refuse is created than the propensity for discarding it due to industrialization and rapid population growth (Chen *et al*., 2010). Human beings create debris in different ways through industrial, commercial, agricultural, as well as domestic. More often than not, however, government and local authorities take all the waste management responsibilities (Pongracz, 2009). The main objective was to evaluate the level of public participation in municipal solid waste management in Techiman, Ghana. The specific objectives were;

- To determine the physical composition and per capita generation of solid waste in Techiman.
- To examine the current waste management practices in Techiman.

Research into this field is necessary to be able to assess the prospects that must be plugged to ensure its full function. This, when completed, can serve as a blueprint for other towns and cities in the country to ensure proper waste disposal.

2. LITERATURE REVIEW

2.1. Waste management practice

Many factors influence the quantity of garbage created in a given human settlement. Rapid population growth coupled with urbanization is one of the factors (UNEP, 2007). The expansion of human settlements has contributed to urbanization. The springing up of factories and industries, the construction of infrastructure such as roads, constitute some of the features of urbanization. Rapid population growth has a relationship with urbanization. Volume and composition of waste generated are determined by factors such as wealth, money, and lifestyle of people (UNEP, 2007). Wealth and money influence the inhabitants of big cities to engage in excessive demand and purchase patterns, almost invariably compelling individuals to hoard. Nonetheless, the size of the household determines the amount of garbage produced; thus, the larger the size, the larger the volume of garbage generated (Niringiye, 2010).

Hoarding of irrelevant items affluently acquired has a rippling effect on the SWM process. Some examples of hoarding on the environment are disposal of manufactured products that contain non-degradable materials such as plastics, thus increasing the volume of garbage without control (Bournay, 2006). In the capitalist economy, manufacturers are bent on making as much profit as the market can permit (Achankeng *et al*., 2003). Because of this attitude, manufacturers are more concerned about getting products that satisfy the consumer without considering their negative effects on the environment. Some companies make minimal efforts to package their products in an environmentally friendly manner. Consumers normally champion the cause of disposing of waste products from the manufacturing entities. If solid waste is not carefully managed, it can cumulatively affect human health, and its effects on the environment will become difficult to resolve.

2.2. Waste prevention

Waste prevention, otherwise known as source reduction are technique adopted in the design, manufacturing, purchasing, or use of materials and products to decrease the quantity of toxic waste materials disposed. An attempt to decrease waste while not producing waste implied waste reduction (UNEP, 2007). USEPA (2005) asserted that waste prevention was the preferred solid waste management technique since it reduced the quantity of waste that the public managed. Source reduction is a common approach to solid waste management, as it efficiently utilizes resources to minimize waste and save money (USEPA, 2005). Activities such as background composting and glass recycling, which completely divert waste materials from disposal facilities, are regarded as a waste prevention strategy (USEPA, 2005).

2.3. Waste generation and storage

Waste generation involves all the processes in which substances, materials, or by-products are thrown away or gathered together for disposal (Hoornweg *et al*., 2005). Waste

generation involves all the processes in which substances, materials, or by-products bereft of their use are thrown away or gathered together for disposal (Hoornweg *et al.*, 2005). Waste generation entails activities surrounding the quantity or volume of things that are identified as no longer useful and enter the waste stream before any waste management practice, such as composting, combustion, recycling, or land filling takes place (Momoh & Oladebeye, 2010). It can also describe or represent the quantity of waste created by a given category of source. The MSW generation worldwide reached 2.02 billion tons, representing 7% annual increase since 2003 (Anon, 2009). MSW generated globally rose to about 37.3% between 2007 and 2011, corresponding to 8% increase per year (Anon, 2009). The total amount of SW generated worldwide is increasing at an alarming pace (Anon, 2009; Mensah & Larbi, 2005). Thus, it is incumbent on all stakeholders of the environment to formulate and fashion out environmentally friendly SWM practices.

2.4. Waste sorting

The grouping or categorization of waste into different elements is known as waste sorting (WS). Waste sorting is either done manually at various homes or by a mechanized way, such as using an automatic separation machine to recover useful materials from waste at recovery facilities or chemical and or biological systems to treat waste. Different kinds of waste materials, such as food waste, yard trimmings, broken bottles, aluminum cans, newspapers, etc., are generated from human activities. Recycling or treatment of waste is normally preceded by waste sorting. Waste collection and sorting are indispensable elements in any solid waste management system, as they determine the feasibility of waste recycling and composting. In sorting, a separating system has been engineered to separate waste materials into different elements (Tchobanoglous *et al.*, 2009). According to Abagale *et al.* (2012), sorting of waste is not very popular in Ghana.

2.5. Collection and sorting of waste from households

Fifty-one households out of the 200 sampled for the survey were further selected from all four wards to assess the physical composition and generation rate, as well as the per capita waste generation of solid waste in Techiman. The number of households selected as a function of the population from each of the four wards was as follows: Takofiano-16, Tunsuoase-12, Dwomor-9, and Sabu-Nzongo-14. Each household was given black polythene bags for the collection of biodegradables (BIO) and blue polythene bags for the collection of non-biodegradables (NON-BIO).

Waste was collected from the households daily for one week. The waste was further sorted to ensure that the black polythene bags contained only biodegradables (food, yard, and food waste) and the blue polythene bags contained only non-biodegradable waste (plastics, paper, metals, glass, rubber, leather, inert, and all other waste). Further sorting and separation were carried out to separate waste into various physical components.

3. METHODOLOGY

3.1. Study Area

The study was conducted in Techiman in the Techiman

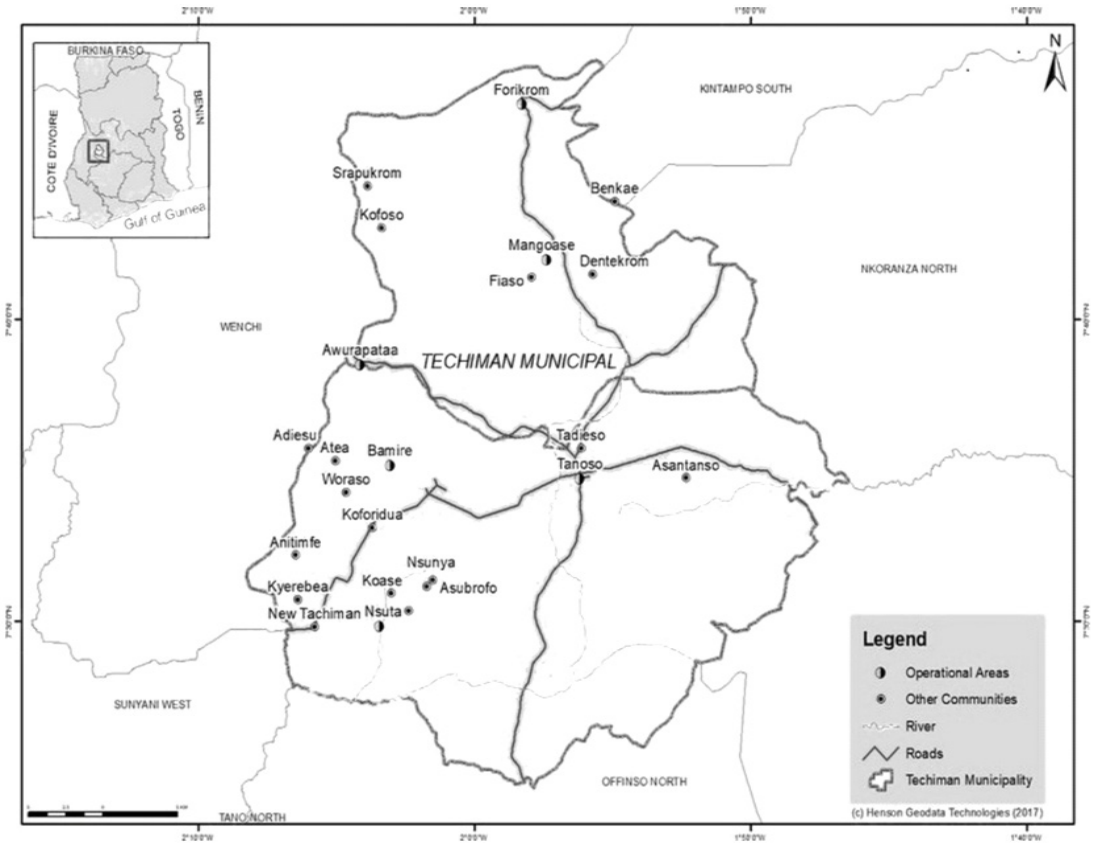

Figure 1. Map of techiman municipality

Municipality situated in the central part of the Bono East Region and lies between longitude 1049 east and 2030 west and latitude 8000 north and 7035 south. It shares common boundaries with four districts, namely, Wenchi in the Bono Region, Techiman North and Nkoranza Municipalities in the Bono-East Region, and Offinso-North District in the Ashanti Region.

3.2. Research design

The descriptive cross-sectional survey was used to collect data from a relatively large number of different categories of respondents at a particular time.

3.3. Data collection tools

Different data collection tools were used to collect information for this research, including administering questionnaires to households and businesses, interview schedules for key informants, mapping, and photography.

3.4. Target population and sample size

The study targeted individuals within the Techiman Municipality with a population of 104,212 according to the 2010 population and housing census. The sample frame comprised a list of shopkeepers, market vendors, households, garbage collectors, and the officials of the Municipal Assembly.

The number of samples needed as a representative of the population needed for the study was deduced from the following formulae n=Z*Z[P(1-P)/(D*D)] – formula for infinite population sample size determination (50,000 people and above) SS= n / [1+(n/population)] for collection of infinite population Where P = True proportion factor in the population or the expected frequency value D = Maximum difference between the sample mean and the population mean, or Expected Frequency Value minus (-) Worst Acceptable Value Z = Area under normal curve corresponding to the desired confidence level n = number of samples of infinite population SS= number of samples for corrected infinite population Sloven's formula:

SS N/1+N (e)^2 (Puopiel, 2010; Ariola, 2006), where SS=Sample size, N=population size, e= margin of error/ error tolerance.

The two formulae above gave a household size of 100-200 for a population between 50,000 and 10 million people

The household sampled as a function of the population is listed in Table 1.

Table 1. Number of households at the ward level

Ward	Sample Size
Takofiano	62
Tunsuoase	47
Dwomor	35
Sabu-Nzongo	56
Total	200

Source: Field survey 2022

3.5. Data collection methods

Both primary and secondary sources of data were collected. The primary sources include the data obtained from respondents, whereas the secondary sources were a variety of published and unpublished written materials. The multiple methods used in data collection were a questionnaire and an interview.

4. RESULTS AND DISCUSSION

4.1. Household size of respondents

The study also revealed that 50% of the respondents were households of less than 4 members, 26% households with 4-6 members, while 18% were from households of more than 6 members. 6% of the respondents recorded the largest household size of 10-13 members. None of the households recorded more than 13 individuals.

Table 2. Household size of respondents

Status	Frequency	Percentage (%)
Less than 4 members	100	50
4-6 members	52	26
10-13 members	12	6
Total	200	100

Source: Field Survey 2022

As expected, the size of a family determines the amount of waste generated (Niringiye, 2010). Households that do not have the capacity to dispose of their waste pay for disposal services when a large quantity of waste is generated (Aggrey & Douglason, 2010). The smaller the family size, the less trash or garbage is generated. It supports the proposition that the size of a family is strongly correlated to the amount of waste generated.

4.2. Physical composition of solid waste

Table 3 shows the amount and the percentage by weight of waste collected from the entire randomly selected households from the four wards in the study area. Of these, Takofiano recorded 74.92% and 25.08% of biodegradable and non-biodegradable, respectively. The waste from Tunsuoase was 61.44% biodegradable waste and 38.56% non-biodegradable waste. Dwomor had 46.13% biodegradable waste with 53.56% non-biodegradable waste. Sabu-Nzongo recorded 47.64% of biodegradable waste against 52.36% of non-biodegradable waste. On average, the study area has 57.53% biodegradable and 42.47% non-biodegradable. Takofiano and Tunsuoase recorded a higher percentage of biodegradable waste than non-biodegradable waste. Dwomor and Sabu-Nzongo recorded a larger amount of non-biodegradable waste compared to the biodegradable waste. A total of 1655.38kg of solid waste was weighed, out of which 974.34kg was biodegradable waste (58.86%), while non-biodegradable waste was 41.14%. Out of the 1655.35 kg of garbage generated in the study area, 974.34kg (58%) was biodegradable, and non-biodegradable waste was 681.04kg (41.14%). This is the situation in many developing countries where the purchasing of unprocessed food seems to be the norm. This practice produces significant amounts of biodegradable waste. In contrast, in developed countries, the buying of processed food seems to be very common, leading to a smaller percentage of biodegradables in households' waste

but a larger percentage of packaging materials. In developing countries, garden and food wastes contribute 65.1% of the total waste (Al-Khatib *et al*., 2010; Gomez *et al*., 2009). Ghana's economy depends on both commercial and subsistence agriculture, and this somewhat explains why food and garden waste are more. Aside, waste due to human consumption, industrial, post-harvest losses, and inaccessible markets for farm products contribute to waste generation (Ministry of Food and Agriculture, 2000).

The percentage of biodegradables in municipal solid waste in selected African cities was as follows: 51% in Nairobi, 56% in India,75% in Kampala, 85% in Accra, and 94% in Kigali (Oyelola & Babatunde, 2008). The 58.56% of organic waste recorded in Techiman Municipality indicates that composting would be a good waste management tool. The biodegradable solid waste from slaughterhouses, kitchens, and food processing industries can be added together and decompose into compost by aerobic bacteria, which is useful in making the soil agriculturally viable. Composting decreases greenhouse emissions from garbage and, at the same time, reduces the demand for chemical fertilizers. Food waste accounted for 20% of waste generated. Plastics/textiles and paper both accounted for 16% whilst ash was the least (18%). Yoada *et al*., (2014) found that in Ghana, that large amount of food debris is generated from waste. Plastic waste generation is on the increase as its fashionable packaging is replacing other forms of packaging. This has a serious rippling effect on the environment in the sense that plastic residue is not degradable. Achanken (2003) lamented the alarming rate of the voluminous plastic garbage in Africa, especially in the urban centers.

It was observed that 44% of waste generated by households is collected by the Municipal Assembly, whilst 16% of the waste is thrown into open space. Observations during the study attested to the fact that some garbage is dumped in the wrong areas. These findings demonstrate that indiscriminate dumping of solid waste exists in some communities in Techiman. These provide suitable conditions for breeding of pathogens causing transmission of sanitation-related diseases such as diarrhea, trachoma, cholera, etc. (Achanken, 2003). Furthermore, the aforesaid research revealed that all stakeholders (Municipal Assembly, assemblymen, NGO's, religious groups, and households) partake in SWM in the community; hence, 22% of respondents reported that SWM responsibilities rest on all stakeholders in SWM in the community. Other respondents indicated that households and Municipal Assembly/private collectors are responsible for the collection of solid waste. These findings are relatively different from a report by Yoada *et al*. (2014) on a study conducted in Accra, which showed that people in urban areas believe that waste management services should be provided by the government at no extra cost to the public. Few people indicated that waste management is the responsibility of both the government and the households.

Table 3. Physical composition of solid waste in techiman

Physical Composition-of Waste	Takofiano		Tunsuoase		Dwomor		Sabu-Nzogo	
	Kg	%	Kg	%	Kg	%	Kg	%
Biodegradables								
Food Waste	177.66	34.39	216.1	58.9	137.99	36.32	142.30	36.24
Wood	111.82	21.64	5.16	1.55	32.64	8.59	37.44	9.53
Yard Waste	97.6	18.89	3.71	1.01	4.60	1.21	187.06	1.86
	387.08	74.92	224.97	61.44	175.23	46.13	187.06	47.63
Paper Products								
Tissue Paper	22.98	4.45	16.78	4.58	9.71	2.56	10.04	2.56
News Print/Cardboard	16.27	3.15	15.41	3.67	9.82	2.59	9.44	2.40
	39.25	7.60	32.19	8.79	19.53	5.14	19.48	4.96
Non-Biodegradables								
Plastics								
Plastic Film	15.34	2.97	24.91	6.80	21.40	5.63	28.80	7.33
Pet	8.61	1.67	5.08	1.39	3.04	0.80	3.99	1.02
Purewatersachet	6.10	1.18	3.69	1.07	2.41	0.63	2.67	0.68
Pp	3.50	0.68	11.53	3.15	6.31	1.67	8.44	2.15
Hdpe	5.30	1.03	3.14	0.86	1.77	0.47	2.03	0.52
Pvc	2.11	0.41	2.98	0.81	2.10	0.55	3.44	0.88
Ps	3.29	0.64	3.40	0.93	1.99	0.52	3.14	0.80
Other Plastics	1.45	0.28	2.09	0.57	1.20	0.32	2.33	0.59

	45.7	8.85	56.82	15.52	40.22	10.59	54.84	13.97
Metals	13.38	2.59	9.33	2.55	5.56	1.46	7.71	1.47
Textiles	8.14	1.58	4.69	1.28	2.69	0.55	2.99	0.76
Glass	11.84	2.29	8.20	2.24	2.11	0.56	3.10	0.79
Leather	2.91	0.56	17.42	4.76	10.14	2.67	13.44	3.42
Inert Materials	3.72	0.72	5.72	1.56	77.14	20.3	64.88	16.52
Miscellanneous	4.61	0.9	6.84	1.87	47.86	1.2.6	39.19	10.0
	44.6	8.63	52.2	144.9	144.9	38.14	131.3	33.44
Total	516.63	100	366.18	100	379.88	100	392.69	100

4.3. Current waste management practices

4.3.1. Mode of disposal of solid waste

Out of the 200 respondents, 44% of them indicated that the municipal authorities collected their waste, while dispose of their waste through burning is 24%.The remaining 16% dispose of their waste through other means, such as the reuse of the waste as feed for animals or as manure.

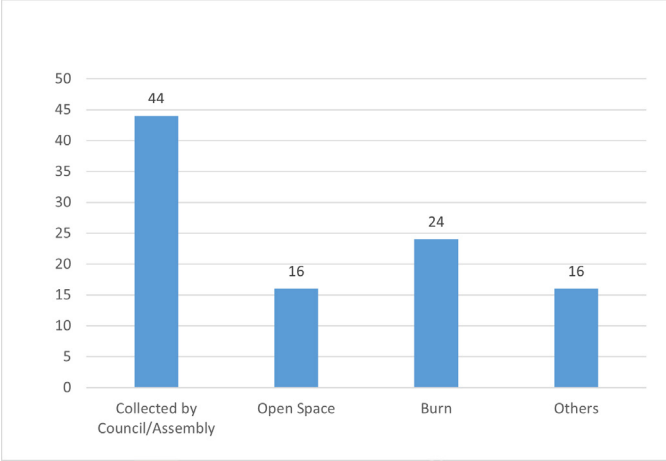

Figure 2. Mode of disposal of waste

4.4. Knowledge of dump site

For the study, there was a need to probe into respondents' knowledge about the number of dump sites. The study showed that 30% of them knew that there were more than two dump sites in the Techiman municipality; 22% of them were aware of only one dump site, whilst 28% did not have any knowledge about the presence of any dump site in Techiman.

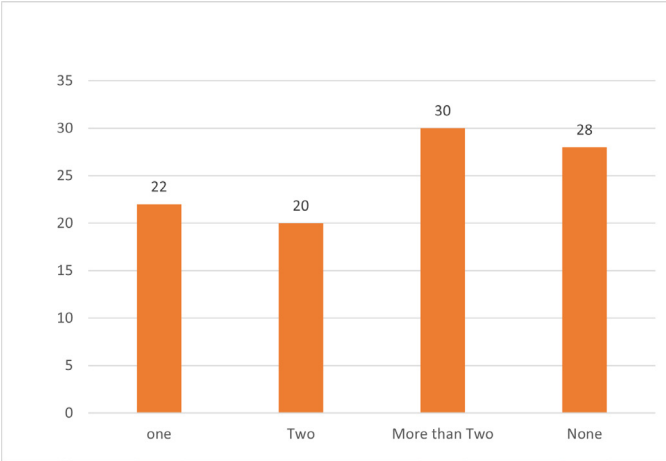

Figure 3. Knowledge of dump site

It was observed that 44% of waste generated by households is collected by the Municipal Assembly, whilst 16% of the waste is thrown into open space. Observations during the study attested to the fact that some garbage is dumped in the wrong areas. These findings clearly demonstrate that indiscriminate dumping of solid waste exists in some communities in Techiman. These provide suitable conditions for breeding of pathogens causing transmission of sanitation-related diseases such as diarrhea, trachoma, cholera, etc. (Achanken, 2003). Furthermore, the aforesaid research revealed that all stakeholders (Municipal Assembly, assemblymen, NGO's, religious groups, and households) partake in SWM in the community; hence, 22% of respondents reported that SWM responsibilities rest on all stakeholders in SWM in the community. Other respondents indicated that households and Municipal Assembly/private collectors are responsible for the collection of solid waste. These findings are relatively different from a report by Yoada *et al.* (2014) on a study conducted in Accra, which showed that people in urban areas believe that waste management services should be provided by the government at no extra cost to the public. Few people indicated that waste management is the responsibility of both the government and the households.

4.5. Waste generation rates

Solid waste generation rates were: (73.80 kg/day), Tunsuoase (52.31 kg/day), Dwomor (45.41 kg/day), and Sabu-Nzongo(56.10 kg/day), while the per capita waste generation was 0.65, 0.62, 0.86, and 0.59 kilograms per person per day in Takofiano, Tunsuoase, Dwomor, and Sabu, Nzongo, respectively.

Table 4. Waste generation rates in Techiman

Ward	Waste generation rate (kg/day)	Per capita waste generation (kg/capita/day
Takofiano	73.80	0.65
Tunsuoase	52.31	0.62
Dwomor	45.41	0.86
Sabu-Nzongo	56.10	0.59

The average per capita waste generated was 0.68 kg/person/day, which is similar to the per capita generation of 0.75 kg/capita for metropolitan and municipal areas (Anon, 2010). This figure is bigger than the national average of 0.5 kg /person/day (Mensah & Larbi, 2005). Developed countries normally produce more solid waste per capita (0.7-1.8 kg/person/day) compared to middle-income or developing countries (0.5-0.9 kg/person/day). This rate is much lower than those reported for some developed or high-income countries like the USA (1.98 kg/person/day), Canada (1.64 kg/person/day), Japan (1.22 kg/person/day) and Germany (1.15 kg/person/day), but slightly higher than those found in developing countries like India (0.41 kg/person/day) and Yemen (0.45 kg/person/day). The Techiman Municipality falls in the middle-income category. This data confirms that generally in urban areas, a direct relationship exists between the economic status of a country and its households' solid waste generation rate (Bernache-Perez *et al.*, 2001).

In 2004 and 2010, waste generated in all the major cities in Ghana showed a slight change in the per capita waste generation, not exceeding 0.11 kg/person/day increment or reduction, except Tema, which had a higher increase in the per capita waste generation with a difference of 0.40 kg/person/day (Anon, 2010). Gomez *et al.* (2010) attributed the increase in municipal solid waste generation rate in developing countries to the gradual improvement in the economic conditions and industrialization. The waste generation rates were: 4.61, 4.34, 6.03, and 4.01 kilograms per person per day in Takofiano, Tunsuoase, Dwomor, and Sabu-Nzongo, respectively. Sabu-Nzongo and Tunsuoase had the lower waste generation rate per household compared with Dwomor and Takofiano. Dwomor recorded the highest generation rate of 6.03, though it has the lowest sample size of the 35 respondents. This is because, besides its proximity to the main market in Techiman, most of the residents in the area are food vendors who generate a lot of solid waste at home.

5. CONCLUSION

Lack of public interest in the solid waste management in the Techiman Municipal area has been increasingly pervasive. The foregoing municipal area under this study is bereft of structures to foster a synergistic association between the inhabitants and the local government. In the area under the current study, household waste mainly contains yard trash, food, wood, paper and cardboard, plastics, glass, textiles, leather, rubber, metal, etc. The study revealed that a high number of debris originating from man-made activities are found in all the four areas under this study. It is asserted that the mean per capita waste is 0.68 kg/capita/day. It was also observed that 44% of waste generated by households is collected by the Municipal Assembly, whilst 16% of the waste is thrown into open space. Many inhabitants of TMA are without the knowledge of the benefits of waste recycling to the environment. Frantic efforts have been made towards waste recycling in the aforementioned area. SWM has both negative and positive ripple effects on sustainable development.

RECOMMENDATIONS

Based on the findings of the study, the following are recommended for efficient and effective public participation in the SWM in the TMA.

i. There should be environmental Education: The inhabitants must be sensitized to the urgent need for public inclusion in the garbage disposal business. Media, religious leaders, and opinion leaders must lead public education exercises.

ii. Waste Reduction Strategy: Home composting facilities (with low or no cost to the household) should be established for households to motivate home composting within the community. Private companies must be included in the SWM conversations.

iii. Enforcement of sanitation bye-laws: Proper enforcement of sanitation bye-laws and also reinvigorating the sanitation courts to sanction those who flout environment laws.

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