

Assessing Municipal Solid Waste Management Practices and Challenges in the Techiman Municipality, Ghana

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Abstract

Managing waste efficiently is essential for building sustainable, livable and healthy communities but this remains a challenge for many municipal governments due to limited municipal budget and other logistical challenges. Such challenges result in ineffective waste collection and disposal. However, identifying the challenges associated with municipal solid waste management often lead to developing solutions to mitigate the problem. This paper assesses the waste management practices and challenges within the Techiman municipality, the regional capital of the Bono East Region. By sampling residents' perceptions and experiences it was observed that households and patrons were dissatisfied with Techiman's Municipal Solid Waste Management (MSWM). Statistically the per capita per day rate of waste generation was 0.48kg/per capita/per day, being higher than Ghana's municipal waste generation of 0.40 kg/per capita/per day. Lack of collection of waste from the transfer stations to the landfill sites has resulted in about 67 heaps of uncollected waste in the municipality. The results show that lack of source separation and recycling, broken down trucks, low participation of private sector in waste collection, non-compliance of by-laws, poor road infrastructure leading to the landfill site, and inefficient landfill site have contributed to the waste problem in the municipality. Resorting to source separation, educating the public on waste management bye laws, increasing private sector participation and establishing engineered landfill sites can substantially contribute to sustainable Municipal Waste Management in the Techiman Municipality.

Introduction

Managing waste properly is essential for building sustainable and livable cities, but it remains a challenge for many municipal governments in developing countries because effective waste management is expensive, often comprising 20%–50% of municipal budgets (World Bank, 2019a). Maalouf et al. (2020) have estimated that over 2 billion metric tonnes of Municipal Solid Waste (MSW) are generated globally with predictions to reach 2.59 billion metric tonnes by 2030. The expansion of urban areas, changing patterns of consumption and industrialisation coupled with scarce natural resources and the extensive practice of traditional system of landfill are resulting in an increase in municipal waste generation that are deteriorating the quality of the environment and posing a risk to sustainable development (Mandal, 2019; Karak et al., 2012). As population increase and consumption patterns change, the quantity of waste generated in the municipal area increases with a commensurate increase in the

non-biodegradable component (Rajashekar et al., 2019; Khandelwal et al., 2019). Plastic waste and greenhouse gas emissions are critical issues facing municipal solid waste management (Moharir et al., 2019; Maria et al., 2019). Managing municipal waste include the introduction of waste policy, waste technology selection and the availability of appropriately trained people in the waste management sector (Kumar et al., 2017; Daskal et al., 2019). Waste reduction at the generation level is one of the key principle of waste policy. Inappropriate waste management methods can have adverse effects on the environment (in particular biodiversity and ecosystems), the climate, and human health (European Union, 2015:3). Ghana has adopted several waste management strategies including policy, legal and institutional frameworks, environmental education and awareness creation and introduced several waste management projects and programmes including waste recovery, recycling and reuse.

Accordingly this research outlines the

challenges hampering efficient solid waste management in the Techiman Municipality by assessing current practices and challenges pertaining to Municipal Solid Waste Management (MSWM) in the Techiman municipality. This is because solid waste management has become a significant urban challenge in Ghana and it contributes to increased health and flood risks. According to the World Bank (2019b), the key issues surrounding solid waste management in Ghana are:

(i) lack of community awareness, (ii) absence of effective collection, segregation and recycling systems; and (iii) limited disposal capacity. For example, in Accra recycling rate is only 5% (Oduro-Appiah et al., 2017). The severity of the waste management problem in the country has even resulted in the creation of a new Ministry of Water Resources and Sanitation in 2017.

Materials and Methods

Description of study area

Techiman Township, also referred to as Techiman, is the municipal capital of the Techiman Municipality and it is also the regional capital of the Bono East Region (Figure 1). It is an urban centre in Ghana. Techiman lies between longitudes $1^{\circ} 49' E$ and

$2^{\circ} 30' W$ and latitudes $8^{\circ} 00' N$ and $7^{\circ} 35' S$. Techiman falls within the forest belt of Ghana with an average rainfall lasting for about nine months within a year.

The population of Techiman has consistently increased over the years. In 2013, the population of Techiman was 104,212 and this increased to 176,934 by 2016 (GSS, 2014a). The municipal growth rate of 3% was higher than the national growth rate of 2.3%. The increased population was due to migration and natural increase. During the 2010 population and housing census about 51% of the total population in Techiman were migrants (GSS, 2010). The high inter-regional migration of persons born in other regions (57.8%) and those born outside Ghana (3.6%) were due to the bustling trade activities facilitated by the Techiman market (GSS, 2014a).

Techiman is a nodal town with trunk roads leading from Sunyani, Kumasi, Wa and Tamale all converging at the city centre thus, creating a vibrant economy (NDPC, 2015). The dominant commercial activities include transport services, catering services, communication services and trade. The Techiman market, the largest foodstuff market in West Africa is located in the township. It attracts both traders and customers from neighbouring countries including Mali, Burkina Faso, Nigeria, and Niger. The days for the market activities start

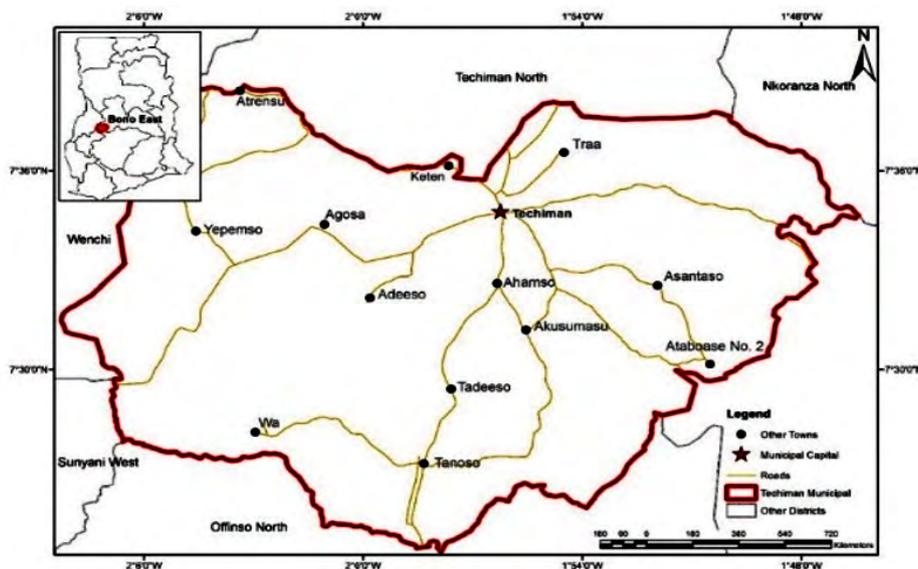


Fig. 1 A location map Showing Techiman as the capital of the Techiman Municipality (Source: Survey and Mapping Division, Lands Commission)

from Wednesday and end on Friday of every week although trading occurs throughout the week. Items traded include food stuffs (yam, vegetables, and grains) and livestock. Techiman has a relatively high consumption rate due to increasing annual mean per capita household consumption expenditure (GSS, 2014b).

The Techiman Township is zoned into 17 different localities (Table 1). Each locality has one large skip bin placed at the transfer station. However, the market and the lorry station each has two skip bins. In all there are about 20 skip bins in the Techiman Township. The capacity of the skip bins were 30 cubic metres. The municipal authority collects waste in fourteen residential localities, while Zoomlion, a waste management company, operates in the market and lorry station. As at 2016, Zoomlion was the only formal private company operating in the municipality. Zoomlion uses trucks, tricycles and wheelbarrows for waste collection.

Data collection instruments

Qualitative data collection methods used in this research included in-depth interviews, key informant interviews, physical observations,

photographs and video recordings. According to Flick (2018) qualitative research intends to understand, describe, and explain social phenomena in a number of different ways including peoples’ experiences, interactions, communications and documents all in seeking to comprehend how people construct and make meaning of the ‘world’ around them. The advantages of qualitative data collection method allows for the human dimension of the research. Such a research allows for expressivity where the attitudes, perceptions and emotions of respondents are made possible. In this research, the qualitative data collection method provided an insight into respondents’ experiences of solid waste management in Techiman municipality by highlighting the challenges associated with solid waste management in the municipality. Recognising that bias could compromise the research, this issue was addressed by engaging with various stakeholders with interest in efficient waste management in the municipality. Thus, households, municipal officials, traditional authorities and market traders were all interviewed. The confidentiality of the respondents, especially

TABLE 1
Location of communal Container Sites and Collecting Agency in the Municipality

No.	Name of Area/Suburb	No. of Containers	Collection Agency
1.	Orange Section	1	Municipal Assembly
2.	Abanim	1	Municipal Assembly
3.	Ahenfie	1	Municipal Assembly
4.	Hausaline	1	Municipal Assembly
5.	Dagombaline	1	Municipal Assembly
6.	Holy Family Hospital	1	Municipal Assembly
7.	Kenten East	1	Municipal Assembly
8.	Kenten West	1	Municipal Assembly
9.	Wangaraline	1	Municipal Assembly
10.	Tunase	1	Municipal Assembly
11.	Aborso	1	Municipal Assembly
12.	Wiaso (site)	1	Municipal Assembly
13.	Tarko	1	Municipal Assembly
14.	Sunyani Station	2	Zoomlion Company Ltd
15.	Cloth Section (market)	2	Zoomlion Company Ltd
16.	Dwomor	2	Zoomlion Company Ltd
17.	Contingency	1	Municipal Assembly

Source: Techiman Environmental Health and Sanitation Unit, Feb. 2016

the government officials, were observed. The respondents were purposively sampled to include households and residents having their houses located next to transfer stations with uncollected heaps of solid waste. Two male respondents led the research team to a nearby polluted stream which they explained used to have fishes but now the stream was so polluted that there were no more fishes in it. No chemical analysis was performed to ascertain the level of pollution since it was not the main focus of the research. The experiences, reactions, perceptions, practices and challenges associated with solid waste disposal and collection within the communities and the measures taken were interrogated. An in-depth interview was also conducted with some traditional leaders in the Techiman traditional council in an attempt to find out about the council's contribution to solid waste management in Techiman and how their activities complement the Assembly's municipal solid waste management. At the open air landfill site at Techiman, a caretaker/operator and a farmer, whose farm was located next to the dumpsite, were interviewed on the day-to-day management of the landfill site. Lastly, market women and food vendors in the Techiman market also shared their views on solid waste management practices including generation, disposal, collection and recycling in the market spaces. All these interviews were conducted between 3 and 5 July 2015.

A second visit, which was conducted from 31 January to 5 February 2016, was to primarily assess Techiman municipality's management approach, policies and by-laws guiding solid waste disposal, collection, recycling, and reuse. It was mainly to ascertain the institutional solid waste management practices and policies. Respondents from the municipal assembly including municipal officers in charge of solid waste collection and Zoomlion, a private waste management company in Ghana and individual subscribers of door-to-door collection were the key informants. Physical observation of the waste content and the location of the transfer station and landfill site as well as the environmental impact on the

surrounding residents and the communities were noted. In addition, the population and housing census data and analysis, municipal reports, and other secondary data were used in this research. Secondary data from the Techiman municipal assembly websites and from census publications and reports were also consulted for population statistics. Strict anonymity and the confidentiality of the respondents in the traditional council were observed. In the end, the responses and inputs from a cross section of relevant stakeholders in the municipality formed the basis of the study and proved very valuable for the ensuing discussions. All the responses of the households, the traditional leaders, the municipal authorities and the private sector were transcribed. The recordings from interviews were also transcribed. After transcription, the data was coded into various themes. The data was analysed using content analysis. Key themes considered in the research objectives were interpreted based on its outcomes and how relevant field respondents intimated it to be.

Statistical analysis

According to Kawai and Tasaki (2016), per capita MSW generation is a core indicator of environmental pressure and a useful measure for evaluating the intensity of waste generated over a period of time. The authors note that the current challenges in estimating MSW generation per capita in developing countries often lead to lower rates of MSW collection efficiency, which may have negative effects on data reliability.

Following Kawai and Tasaki (2016) the per capita municipal waste generation in the Techiman municipality was calculated based on equations (1) and (2), where W is the annual total waste collected (tonnes per year), v is the total volume of waste collected within the municipality from beginning of the year to end of the year over 365 days, and WT is the per capita waste generated per day per person. WT is a function of the total waste collected W divided by P , the total population with municipal waste collection services. The

study was not able to specifically determine the exact population with municipal solid waste collection service. Hence, the total population of the municipality was used based on the interviews conducted with the municipal authorities who confirmed that almost all the population had access to a form of waste collection service including the door-to-door collection service or dumping at the transfer stations. This limitation may result in an underestimation or overestimation of municipal solid waste generation per capita.

$$W = \sum_{i=1}^{365} v \tag{1}$$

$$WT = \frac{W}{P} \times \frac{10^3}{365} \tag{2}$$

Results and Discussion

Composition of solid waste

The results of the research showed that solid waste in the Techiman Township consist of both organic and inorganic materials including sand, ashes, paper, cardboard, food waste, plastic packaging, glass, scrap metal and dead animals. By visual inspection, agricultural produce formed the majority of all the waste generated. This could be attributed to the vibrant foodstuff market in the Techiman Municipality contributing significantly to the high composition of organic waste in the MSW. In addition, exchanging and wrapping of goods, which results in the packaging and re-packaging of purchased items, significantly contribute to plastic and paper wastes. According to Alhassan *et al.* (2010), market waste constitutes about 40% of the total municipal waste stream in

Ghana’s urban areas. Aye and Widjaya, (2006) observed that waste from traditional markets in Indonesia is the second largest stream of municipal solid waste after household waste with a higher organic content which may have greater potential to be managed on a business scale for biogas and electricity production compared to household wastes. In 2015, the government threatened to ban plastic use in the country but that was never implemented. Several other policy initiatives including the introduction of bio-degradable additive to plastics have come into play since 2015 under the EPA Act 490. Even though several researches have shown that organic waste may be used to produce compost and biofuels in Ghana (Duku *et al.*, 2011; Asomani-Boateng, 2016), there were still no specific and formal programmes to promote separation of waste in the municipality. Source separation was not practiced at the household level although the Municipal Environmental Officer intimated that his outfit was planning to venture into a private partnership to process compost and recycle plastics.

Waste generation rate

The estimated volume of waste collected from the 17 suburbs in 2015 was 6227 metric tonnes representing 20% of all waste generated in the municipality (Table 2). This means that 80% of all MSW generated in the township were not collected. Zoomlion handled just about 27% of total waste collected.

Following Kawai and Tasaki (2016), the Techiman municipal solid waste generation per capita from January to December in 2015 was estimated to be 31,135 tonnes taking into consideration the 80% uncollected waste. Computing from the population of

TABLE 2
Monthly solid waste collected by the Assembly and Zoomlion in 2015

Institution	Month												Total (tonnes)
	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assembly	403	392	411	386	405	387	379	345	349	380	359	352	4548
Zoomlion	147	142	144	151	140	139	143	140	122	118	148	145	1679
Total												6227	

Techiman municipality (176 - 934) and the estimated total waste generated in a year, the annual kg per capita weight of waste generated in the municipality in 2015 was 175.97kg giving a daily estimated per capita solid waste generation rate of 0.48kg/person/day which is higher than Ghana's municipal waste generation of 0.40 kg/per capita/per day (Miezah et al., 2015). The results are supported by Francis Xavier et al., (2018) who stated that Techiman municipality was facing serious waste management challenges. Though the daily waste generation in 2018 was 325 tonnes, yet only about 21% were collected (Baffour-Mensah, 2018). In March 2018, the Techiman Municipal Assembly launched a sanitation programme to rid the Municipality of filth. The high waste generation could be attributed to the volume of waste that is generated in the Techiman market. According to Miezah et al., (2015) the geographical location, culture, occupation, and the kind of economic activity determine waste characteristics and quantity of waste generated. Again, the high volumes

of waste generated within the municipality can also be attributed to the lack of household source separation and recycling behaviour since there were no infrastructure for source separation at the household level. Access to recycling facilities, education, incentives, social factors, altruistic and regulatory factors tend to influence recycling habits (Steg et al., 2014; Nguyen et al., 2015; Ma and Hipel, 2016). Source separation of MSW is an efficient municipal solid waste management strategy for enhancing recycling and minimising waste in developed countries (Zhang et al., 2012). Oduro-Kwarteng et al. (2016) assert that there is potential for recycling through source separation programme in low-and middle-income communities in Ghana.

Waste collection and challenges

Uncollected waste

During the time of survey, there were about 67 heaps of rubbish dumps in the municipality. Figure 2 shows some of the rubbish heaps at Kenten, Dagombaline and along a street. The



Fig. 2 Uncollected waste spilling into homes and streets at various transfer stations in the municipality. (Source: Authors, 2015 and 2016)

uncollected waste in various communities had developed into mountainous heaps of rubbish overflowing into the compounds of nearby houses and on to the streets.

The overflowing skip containers with tonnes of uncollected waste in the transfer stations had resulted in indiscriminate dumping of refuse in the open space, burning and burying of waste. The District analytical report (GSS, 2014a), indicated that public dumping sites of refuse in the open space (49.7%) and in containers (38.4%) were the main methods of solid waste disposal in the municipality while other methods of disposal including burning and burying accounted for the remaining 11.9%. Efficient collection of waste within the municipality is hampered by inadequate logistics, poor infrastructure and meagre municipal budget. In 2015, only one percent of the total municipal budget, equivalent to GHS 166,000, was earmarked for solid waste management in the Techiman Municipality (Republic of Ghana, 2016). Guerrero *et al.* (2013), after extensive review of several studies, identified that poor planning and improper bin collection, lack of information on time and schedule for waste collection, absence of infrastructure and vehicles for waste collection, poor roads, lack of transportation facilities, inadequate supply of disposal containers and priced disposal all influenced collection, transfer, transport and disposal of waste management system performance. Waste collection, transportation and disposal practices in the Techiman municipality were inefficient due to inadequate skip containers, frequent breakdown of waste collection vehicles, and no schedule for collection.

Situation at transfer stations

Residents staying close by the rubbish dump at *Kenten* explained the processes that led to the accumulation of waste in the residential area and the inconveniences and health hazards associated with it.

Resident 1: *“We have been staying in the community for about eight years. Initially there was no rubbish heap but within*

the last six years the heap kept on increasing. Now it is almost covering the electricity poles..... The stench and surface runoff from the uncollected rubbish is causing great discomfort to us. The assembly has just cleared a portion of the dumpsite and they are planning to bring a new [skip] container since they cannot clear all the existing rubbish heap immediately”.

Resident 2: *“You always find polythene bags flying around Also, when it rains it is terrible, you cannot endure the stench”.*

Another respondent expressed his helplessness and mentioned some of the initiatives taken to manage the situation.

Resident 3: *“This refuse heap is giving us problems but there is nothing we can do. Some people dump the refuse at the edge and when you confront them, they verbally abuse you. The Assembly tried to use communal labour and open air burning to manage the rubbish but that didn't help matters. We always burn the plastic bags because the wind blows them into our homes”.*

Although the supply of waste facilities and long walking distances to waste disposal containers or sites increase the probability of waste dumping in open areas and roadsides significantly and affect waste disposal choices, households in Techiman municipality would not like to have transfer stations sited near their houses because of health concerns, bad odour and the fear that their property would be devalued. The findings are in tandem with what Tadesse *et al.* (2008) observed in Ethiopia. There is the need to conveniently site containers and at the same time make it accessible to households.

Equipment

The municipal officer also revealed that only 10 communal bins were operational while the remaining 25 communal bins were not functioning. The trucks acquired in 2009, had broken down and it was only one skip truck

and two tipper trucks functioning (Table 3). According to the municipal officer, collection and disposal of waste at the various transfer stations becomes challenging when the single truck breaks down. Hence, the assembly was partnering with Zoomlion, a private waste company in the collection and disposal although in very limited communities. Zoomlion was managing only six transfer stations while the remaining 14 stations remained under the jurisdiction of the Municipal Assembly. Meanwhile, Zoomlion trucks were relatively strong and in good working condition.

By-laws

The uncollected waste at the transfer stations had also compelled some residents to indiscriminately dispose of waste in unapproved spaces. The Chief Environmental Health Officer of the Techiman municipality however, explained that he was not sure the public knew the by-laws and regulations pertaining to improper waste disposal as a bookable offence. Hence, he stated that,

“So, whenever we get to the houses ... we caution the residents to desist from such practices and explain to them the consequences of such action. We then record in our inspection book and when we inspect the facility again and we notice that the same problem persist we take them to court”.

The Techiman Municipal Assembly has comprehensive by-laws which is in pursuance of Section 79 of the Local Government Act of 1993 (Act 462). These by-laws empower local governments to enact by-laws for efficient functioning of its operations. According to the by-laws, the Municipal Environmental Officer is responsible for premises inspection, public health education, medical screening of food handlers, evacuation of solid and liquid solid waste, handling of public complaints on sanitation, and monitoring and evaluation of environmental health operations. MSWM in Ghana is collectively overseen by the Ministry of Local Government and Rural Development, Ministry of Environment and

Science, and the Environmental Protection Agency (EPA). The EPA has rolled out several waste management intervention programmes including, the National Municipal Solid Waste Management Guidelines, a manual for the preparation of District Waste Management Plans and Guidelines in 2002, the National Source Waste Segregation Programme in 2013 and the Hazardous and Electronic Waste Control and Management (Act 917) in 2016. In addition, the EPA has plans of establishing landfill facilities across the country as a way of containing the ever-increasing volumes of municipal waste. Even with all these guidelines, plans and legislations, waste management in the Techniman Township was not efficient because of inadequate qualified staff at the municipal assembly.

Door-to-door service

The Municipal Assembly also had the ‘door-to-door’ service with very few registrants. In 2016, the subscriber was entitled to a 240-litre plastic dustbin and had to pay a monthly levy of 15 Ghana Cedis (USD 3.84). It was observed that a number of homeowners in the communities had not subscribed to the ‘door-to-door’ collection service instead, a few small-scale businesses patronised the service. However, frequent breakdown of trucks sometimes resulted in uncollected waste which impacted on the efficiency of the door-to-door service. A subscriber recounted her experience when her rubbish was left uncollected for two weeks. She said,

“Sometimes the “samansaman” (town council officers) come here because of the rubbish and I quarrel with them. One of them came here some time ago to arrest me and I told him to go and arrest Zoomlion before they arrest me. I quarreled with him. Later one of the senior officers came to apologise. I told him to go and arrest Zoomlion because they supplied the container”.

An officer explained the municipal assembly’s MSWM strategy stating that, *“We are encouraging households to subscribe*

to the door-to-door service and pay for waste collection. This will reduce solid waste disposal at the communal dumping sites. We intend to introduce the collector base system in the near future. In that case households would be expected to pay before dumping waste at the transfer stations. However, we have to first ensure that we do not have any backlog of rubbish sitting at the transfer stations”.

The municipal authority and private solid waste collection contractors often concentrate their efforts in wealthy residential areas leaving low income areas unattended (Fei-Baffoe *et al.*, 2014). That is because the well planned high income residential areas have good access roads and households are often able and ready to pay for solid waste collection compared to the low-income communities (Fei-Baffoe *et al.*, 2014).

Private sector participation

Zoomlion Company is the only private waste firm in Techiman municipality and they partner with the Assembly in waste collection. According to a supervisor of Zoomlion for the municipality, in addition to collecting waste from designated transfer stations, they employ about 194 persons to do sweeping of the streets and cleaning of gutters and transferring collected waste to the transfer stations using tricycles. Zoomlion had about 25 tricycles and 36 wheel barrows. When questioned on the role of Zoomlion in Techiman’s municipal waste collection system, the supervisor responded;

“The assembly is responsible for the piled up waste in other areas [14 localities]. We collect about five or six big skip containers daily and the rest is supposed to be taken by the Assembly. You know the Assembly has got its own way of doing things, we are contracted to do some part of it and we cannot talk about the rest. Yes, we have the capacity to do more if we are given the chance. There are people who are assigned to our portions or areas so we don’t even wait for it (skip) to get filled up before it is collected”.

Private sector involvement in municipal solid waste management in the Techiman municipality was very low. The results showed that Zoomlion was the only private company operating in the municipality. This could be explained by the meagre municipal budget. Private sector involvement in municipal solid waste management could increase service coverage (Oteng-Ababio, 2010) and the growing involvement of the informal sector in MSWM is also recognised (Oteng-Ababio, 2010; Ezeah *et al.*, 2013; Mbah and Nzeadibe, 2017; Aparcana, 2017; Ferronato *et al.*, 2019). Overlooking the resourcefulness of the informal urban poor and giving very little recognition for the informal sector may culminate in the stalling of important MSWM projects (Oteng-Ababio *et al.*, 2013). However, total dependence on the private sector could be disastrous since private sector participation in MSWM in Ghana has not increased collection and recycling rates (Oduro-Appiah, 2019). This is because the private sector may also face challenges due to low-cost recovery as a result of inefficient refuse fee collection system, use of inferior equipment, short contract duration, absence of waste recycling plants, inaccessible roads and weak implementation of municipal policies and by-laws (Kirama and Mayo, 2016).

Waste disposal at landfill sites

The Municipal solid waste is dumped in an open landfill that is not engineered and is situated at the urban fringe (Figure 3). The untarred road leading to the landfill site is in a very bad condition. It is usually muddy and not motorable when it rains. The 1 km² landfill site had been in existence for about 15 years. At present there is very limited space left for future expansion because the community was developing and houses were being sited close to the landfill. The sprawling condition at the landfill site had led to continuous shoving and leveling of refuse to create space for more dumping. According to the Zoomlion officer;

“The place [land fill site] is not big enough so it’s always choked. We are unable to dump



Fig. 3 Open landfill site in Techiman municipality showing open burning of refuse, poor access road and scavenging of plastic waste. (Source: Authors, 2015)

more waste until the overflowing waste at the edges of the landfill site had been shoved. When that happens we do not collect and transport additional waste from the transfer stations. Again, the deplorable state of the roads make them unmotorable when it rains. The trucks cannot access the landfill site”.

There was also regular burning of the refuse leading to air pollution and there were no caretakers. As part of the future plans of the assembly, the municipal officer revealed that a 30-acre land has been acquired and it is yet to be developed into a modern landfill to conform to Environmental Protection Agency (EPA) standards. Scavenging for plastics, electronic waste and metal scraps at the landfill site was practiced.

Open landfills are the most practiced option of waste disposal in Ghana but they do not meet EPA's engineering and environmental requirements and they pose health risks to people and ecosystems in and around its vicinity (Asomani-Boateng, 2016; Owusu et al., 2014). Lack of engineered landfill sites in the Techiman Municipality exposes residents to several health hazards. The challenges associated with the landfill site, including bad road system, open dumping and open burning result in environmental contamination and landfill leachate which contains concentration of organic carbons, ammonia, chloride,

heavy metals (Ferronato & Torreta, 2019). Landfilling should be considered as the last option because of the large space required, the high risk of leakage into the air, water or soil and the fact that it makes less use of the energy content of waste (Messeneo and Panno, 2008). Instead, Resource Recovery from Waste (RRfW), which represents a transition stage toward a sustainable circular economy and adopting a wide range of strategies including design for durability, reuse and reparability, recycling and recovering materials, energy recovery, and controlled storage in landfills should be promoted to achieve greater resource efficiency (Lag-Brotons, et al., 2020).

Conclusion

The research discussed solid waste management practices in the municipality including the disposal practices at the household level, the waste situation at the transfer stations, the logistical challenges faced by the Techiman Municipal assembly and the difficulties associated with waste disposal at the landfill sites. Generally, households were dissatisfied with the level of waste management services in the municipality. The results show that lack of source separation and recycling, broken down trucks, low participation of private sectors in waste collection, non-compliance of by-laws, poor road infrastructure leading

to the landfill site, and inefficient landfill site have contributed to the waste problem in the municipality. Resorting to source separation, educating the public on waste management by-laws, increasing private and informal sector participation and establishing engineered landfill sites can substantially contribute to sustainable Municipal Waste Management in the Techiman Municipality. In addition, the introduction of plastic tax combined with efficient waste management systems can be used to address the plastic menace in Techiman municipality and other urban centres in Ghana. According to Walker *et al.*, (2020) plastic tax may be a suitable strategy to reduce plastic waste as it is likely to influence the design, production and consumption. Local networks built around market and commodity queens in indigenous open-air markets have the potential to sustainably manage market organic solid waste through composting (Asomani-Boateng, 2016).

Public education need to be intensified for people to know the by-laws and appreciate the impact of waste on the environment. Effective solid waste management campaigns should be initiated by city authorities and supported by traditional authorities, community-based associations, civil society and all identifiable stakeholders. Since waste management has serious implications on the population and economy, additional resources should be committed to achieve an efficient solid waste management. Policy makers in Techiman municipality need to begin to appreciate that waste is a great resource that they can tap into instead of seeing waste as a problem that needs to be managed (Oteng-Ababio, 2014). Plastic could be recycled and organic waste composted and this could generate income for the municipality and create employment for the people. At the same time, it would lead to waste reduction at the landfill sites. Source separation, recycling and composting of solid waste in Techiman Township would result in effective MSWM and prevent health disaster. Hence, strategies that combine efficient waste collection and disposal systems with law enforcement are necessary for sustainable

waste management in the Techiman Municipality.

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