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Research article

An assessment of house-hold solid waste management in a large Ghanaian district

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ABSTRACT

The importance of waste management cannot be overemphasized. Improper waste management and disposal has rippling effect on the environment and human health. The aim of this study is to assess solid waste management among household in a large Ghanaians district. Multi-stage sampling technique comprising a cluster, simple random sampling, and systematic sampling techniques were used to select 600 respondents for the study. Data was analyzed using (SPSS) version 23.0. Results indicates that communal waste collection bins were far from households as confirmed by the majority (57.3%) of the respondents. The majority (56.5%) of the households walked a distance of 11–15 min before reaching the refuse site. The study found that the number of waste collection point in the community were few (1–3 collection bins) as confirmed by majority (92.2%) of the respondents. The distance from the center of the community to the final waste disposal site covered 1–2 h journey. There was a significant relationship between the number of waste disposal sites in the community and the average distance (in kilometers one way) from the city center to a disposing site. In conclusion, the study found that communal waste collection bins were far from households; number of waste collection point in the community were few. This indicates that the distance from the center of the community to the final waste disposal site covered 1–2 h journey. Based on the major findings of the study, we recommend that district assembly should provide waste collection bins to every household to ensure that residents do not dispose their housrhold waste indiscriminately. District by-laws should be strengthened to ensure proper household waste disposal at all districts in Ghana.

1. Introduction

Globally, the rapid increase in population leads to a dramatic upsurge in solid waste production, with austere socio-economic and environmental effects on society (Lagerkvist and Dahlén, 2019). Currently, there is a general consensus on the guidelines for sustainable solid waste management, however, limited efforts have so far been done in this regard, and these are adapted to the specific guidelines and needs of each national or regional authority. New strategies are required to design various and variable urban models for effective waste management.

Today urbanization is one of the major factors contributing to solid waste generation in most part of the world (Kumar and Pandey, 2019; Chen, 2018; Anarfi, 2013). In Africa, waste is unsightly and lowers the morale of communities. Improper waste management is known to create conditions for the spread of diseases (World Bank, 2011; Osei et al., 2010; United Nations Environmental Programme (UNEP), 2009). The collection of solid waste (SW) is a key step in all waste management plan. It is one of the greatest challenges confronting waste managers globally.

(Ogra, 2013; Chalkias and Lasaridi, 2009; Tinmaz and Demir, 2005; Environmental Protection Agency, 2002).Irrespective of the strategies and methods of waste management employed, the first step is that waste in which ever form it is must foremost be collected. The waste collection scheme ought be tailored to meet the objective of the intended waste management processing procedure such as landfilling methods or resource recovery. Solid waste collection mostly comprises people and a means of carriage to a transference station, treatment facility, or final dumping site (Oelofse et al., 2018; Worrell, 2012). Collection techniques may differ obviously between developed and developing countries. The phenomenon of house-to-house collection is very common particularly for household solid waste collection in most developed nations

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(Satterthwaite et al., 2018). However, the application of this method has mostly been very low mainly in developing nations due to several challenges including financial, population expansion and other economic difficulties (Awuak, 2018; Bezama and Agamuthu, 2019).

In Sub-Saharan Africa, waste collection systems such as communal container collection methods appear most dominant in many nations (Awuah, 2018; Lloyd, 2019; Lagerkvist, and Dahlén, 2019). In this kind of system, common containers (waste bins) are provided at dedicated points within neighborhoods for households to drop-off their solid waste. Trash collection vehicles then pick up these containers and empty off the trash at designated disposal spots and return the containers to their original locations. However, this trash collection method is fronted with several difficulties most of the time leading to uncollected. Thus, there is overflow of waste, ground dumping at collection sites, and at unauthorized spaces (Atkinson et al., 2019).

The unplanned siting of dump sites or communal containers could pose threats to water resources, particularly source water sources such as rivers and streams. Eventually borehole, hand-dug wells and other groundwater sources are also affected.

Several gaps exist within efficiency and effective waste domain in Ghana. although some work has been done, more questions remain unanswered (Kretchy et al., 2019; Boateng et al., 2019; Owusu-Nimo et al., 2019).

First an efficient waste management requires data on geographical location of landfill and dumpsites, this is critical for an effective and timely waste management regime. Thus, leading to efficient waste collection and consumer satisfaction; whilst sustained ineffective services leads to dissatisfaction on the part of the client resulting in indiscriminate refuse disposal by various households that may result in environmental pollution and spread of disease (Francis-Xavier et al., 2018).

The efficiency of waste management service as relates to human interface within the waste management delivery domains remains largely unknown. For example, a holistic assessment of clientele perceptions of efficiency across districts regarding the services of a given waste management provider is virtually non-existent. Yet it is critical to have integrated information about the efficiency of waste management delivery as well as customer satisfaction in order to aid policy directions and enhance sustainable waste management. However a holistic assessments of the efficient or quality of waste management services cannot be complete without views from patron of the waste service so provided (Udofia et al., 2018).

The purpose of this study is therefore, to evaluate solid waste management among household aimed at identifying the adequacy of the communal containers; distance from households to the dumping site and distance from the collection point to the final disposing site in a large Ghanaian district.

2. Methodology

2.1. Study design and sample size

The study employed cross-sectional design to obtain quantitative data using questionnaires. The questionnaires though were self-administered, paraphrased into the local language for respondents who for literacy reasons, could not answer in English. Content and face validity of the questionnaire were determined by a panel of experts before and after pretesting.

2.2. Sampling technique

The study utilized multiple sampling techniques. Thus, a multi-stage sampling technique comprising a cluster, simple random sampling were employed. The district under study was thus divided into six sub-districts called clusters. Two hundred (200) respondents were then selected from each of the three sub-districts for the study. A total of 600 respondents were selected for the study.

2.3. Data collection and analysis

This study took place between 1st December 2017 and 31st March 2018. A standardized structured questionnaire specifically designed to meet the goals of this research was utilized for data collection. Field inspection of questionnaire data was carried out daily after the interview was conducted, and any errors were immediately verified and corrected. The final survey instrument comprised of 30 questions in five major areas: Demographic information (7 items); distance of communal bin (container) from households (9 items); number of collection points in the community (5 items); distance from collection point to disposal site (5 items) and health outcomes (4 items). Final instrument was administered to the subjects via self-administered questionnaire method. It took approximately 25–35 min to complete the instrument.

Five experts in waste management measurement and evaluation, assisted with the determination of face validity of the instrument. The average overall face validity was equal to 95%. Reliability for internal constituency was done by Alpha (Cronbach's) test and it was equal to reliability coefficient of 0.87, which is adjudged high reliability.

3. Ethical consideration

Both verbal and written concern was sought from the respondents before data was obtained. Adequate information was provided to the respondents with regards to the aims of the study. It was made clear to the respondents their participation was voluntary and were at liberty not to participate. They also were assured of confidentiality. All respondents' personal identifiers were deleted form summarized data, ensuring confidentiality.

4. Statistical analysis

Data obtained from the questionnaires were coded and analysed with SPSS version 23. Discrete variables like gender and educational status were described using frequencies and percentages. Bivariate relationships were analysed using Chi Squared (X^2) tests or Cramer's V exact test (Garcia-Perez and Nunez-Anton, 2003; Beasley and Schumacker, 1995). All statistical tests employed in this study were two-tailed and were considered to be significant when alpha = 0.05 or less.

5. Results

The socio-demographic characteristics of the respondents include gender, age, religious affiliation, marital status, educational level, occupation, and income level are presented in Table 1.

5.1. Socio-demographic characteristics of respondents

The gender distribution shows that majority (55.2%) of the respondents in the study were females whilst the remaining percentage (44.8%) were males. The age distribution showed 207 (34.5%) of the respondents were within the age range of 30–39 years. The ages ranged from 18 to 60 years. The majority (66%) of the respondents were Christians. Large proportions (70%) of the respondents were also married. Besides, a large proportion (26.8%) of the respondents had no form of education as compared to those who had primary (21.8%), JHS (21.3%), SHS/TEC (12.3%), and tertiary (17.7%) education. A good number (N = 176) of the respondents representing 29.3% was self-employed whereas good number (N = 193) of the respondents representing 32.2% (50%) had an income level of GHC100 -199 per month.

5.2. Type of solid waste generated

Table 2 shows that the highest (N = 210) type household solid waste generated is plastic and rubbers with a mean score of 4.38 followed by organic vegetables (N = 177) with a mean score of 3.89.

Table 1. Socio-demographic characteristics of respondents.

Variable	Response	Frequency	Percentage
Gender	Male	269	**44.8**
	Female	331	**55.2**
	Total	**600**	100.0
Age	≤18	19	**3.2**
	19–29	47	**7.8**
	30–39	207	**34.5**
	40–49	168	**28.0**
	50–59	159	**26.5**
	Total	**600**	100.0
Religious Affiliation	Christian	396	**66.0**
	Muslim	142	**23.7**
	Traditional	62	**10.3**
	Total	**600**	100.0
Marital Status	Single	129	**21.5**
	Married	420	**70.0**
	Divorced	41	**6.8**
	Widowed	10	**1.7**
	Total	**600**	100.0
Educational level	Not attended school	161	**26.8**
	Primary	131	**21.8**
	JHS	128	**21.3**
	SHS/TECH	74	**12.3**
	Tertiary	106	**17.7**
	Total	**600**	100.0
Employment status	Farmer	175	**29.2**
	Private sector employee	86	**14.3**
	Civil Servant	77	**12.8**
	Unemployed	86	**14.3**
	Self-employed	176	**29.3**
	Total	600	**100.0**
Income level	Less than GHC 100	82	**13.7**
	GHC 100 -199	193	**32.2**
	GH? 200–299	120	**20.0**
	GH?300–399	112	**18.7**
	More than GH?399	93	**15.5**
	Total	600	**100.0**

Source: Authors Compilation (2018).

The maximum category of household residents who mostly generated plastics and rubbers was recorded among the self-employed who are mostly traders and minimum was recorded among farmers. The maximum household respondents that mostly generated organic vegetables were farmers whereas the minimum was recorded among civil servants. The finding also indicated that at 95% confidence level and 5% significance level, there was a significant association ($p = 0.000$) between household occupation and the kind of waste generated in the study area.

Table 3 depicts that chi-square computation of the relationship between sorting of waste before disposal and demographic characteristics of the respondents such as age and education at 95% confidence level and 5% significance level. There was enough evidence that sorting of household waste before disposal was highly associated with age and education level of the respondent with probability values of 0.000, and 0.000 respectively. The findings indicated that majority ($N = 441$) of the household residents representing 73.5% did not sort their waste at all before disposal whereas the remainder, 159 (26.5%) did sort their waste sometimes.

In Figure 1 majority ($N = 344$) of the respondents, representing 57.3% affirmed that the distance between household and the dumping site was far, 186 (31%) of the respondents also affirmed that the distance was not far whereas 70 (11.7%) of the respondents attested that the distance from place of residence to the waste dumping site was very far.

The results in Figure 2 indicated that majority ($N = 339$) of the respondents representing 56.5% walked a distance of 11–15 min before reaching the dumping, 126 (21%) of the respondents covered a distance of 6–10 min before reaching the dumping site, 120 (20%) of the respondents covered a distance more than 15 min before reaching the dumping site whereas few,15 (2.5%) of the respondents covered a distance of 1–5 min before reaching the dumping site.

Table 4 shows that at 95% confidence level and 5% significance level, there was a significant association between household payment for the waste generated and their socio-economic statuses such as educational level and income level. The association between occupation of respondents and the payment for the waste generated was found to be insignificant. Finding indicated that the majority ($N = 460$) of the respondents representing 76.7% did not pay for the waste generated when disposing of whereas the remainder, 140 (23.3%) paid for the waste generated.

Table 3. Relationship between sorting of household waste and demographic characteristics.

Variable	Response	Sorting of Waste Before Disposal			*Chi-square*	*P-value*
		Sometimes	Not at all	*Total*		
Age	≤18	0	19	19		
	19–29	14	33	47	38.621	0.000
	30–39	58	149	207		
	40–49	67	101	168		
	50–59	20	139	159		
	Total	**159**	**441**	**600**		
Educational level	Not attended school	4	157	161		
	Primary	33	98	131		
	JHS	45	83	128		
	SHS/TECH	27	47	74	79.753	0.000
	Tertiary	50	56	106		
	Total	**159**	**441**	**600**		

Source: Authors Compilation (2018).

Table 2. Type of solid waste generated with respect to occupation of respondents.

Type of Solid Waste	Mean	N	Std. Deviation	Maximum	Minimum	Mean Square	F	Sig.
Plastic and rubber	4.38	210	1.665	Self-employed	Farmer	40.165	17.349	**.000**
Organic or vegetable	3.89	177	1.488	Farmers	Civil servant	.588	.254	**.615**
Glass and ceramic	2.89	32	.942	Self-employed	Civil Servant	50.059	21.623	**.000**
Paper	2.16	116	1.509	Self-employed	Farmer	2.315		
Textile	2.42	19	1.071	Unemployed	Farmer			
Wood	3.28	46	1.464	Self-employed	Private sec.			
Total	3.00	600	**1.622**	**Self-employed**	**Farmer**			

Source: Authors Compilation (2018).

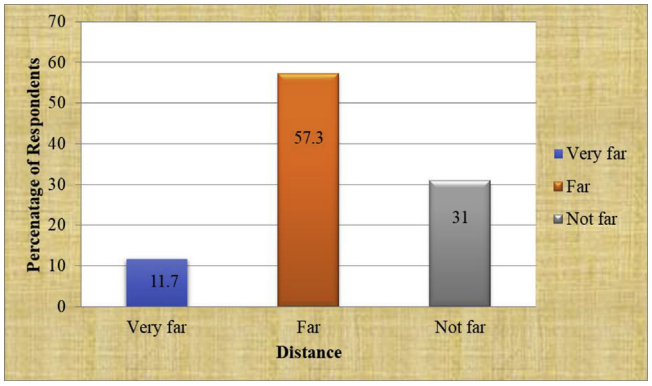

Figure 1. Distance from place of residence to dumping site.
Source: Authors Compilation (2018).

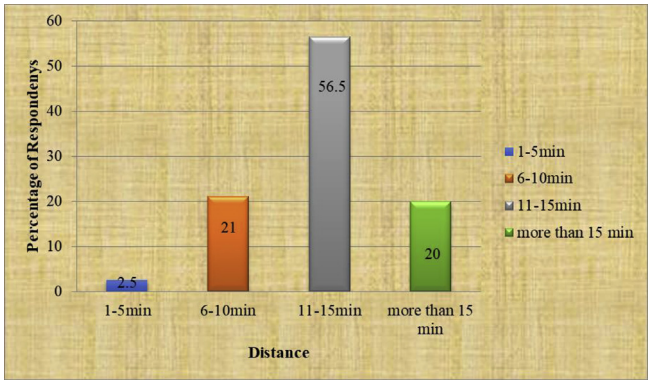

Figure 2. Time required reaching dumping site.
Source: Authors Compilation (2018).

Table 4. Relationship between payment of waste and socio-economic status of households.

Variable	Response	Payment of Waste Generated			*Chi-square*	*P-value*
		Yes	No	*Total*		
Occupation	Farmer	47	128	175		
	Private sector employee	17	69	86	4.758	0.313
	Civil Servant	13	64	77		
	Unemployed	24	62	86		
	Self-employed	39	137	176		
	Total	140	460	600		
Educational level	None	48	113	161		
	Primary	33	98	131		
	JHS	13	115	128		
	SHS/TECH	16	58	74	18.040	0.001
	Tertiary	30	76	106		
	Total	140	460	600		
Income Level per month	Less than GH? 100	32	50	82		
	GHC100 -199	50	143	193		
	GHC 200 - 299	17	103	120	18.928	0.001
	GHC300 - 399	22	90	112		
	More than GHC399	19	74	93		
	Total	140	460	600		

Source: Authors Compilation (2018).

The findings in Table 5 indicated that 113 out of the 140 households that paid for the waste generated paid more than GHC10 which represents 80.7%, 19 (13.6%) of the respondents paid between GHC5-10 whereas the remainder, 8 (5.7%) paid less than GHC5. Findings also indicated that at 95% confidence level and 5% level of significance, there was a strong associated between distance to waste dumping site and the amount paid by the household for waste disposal.

Table 6 shows relationship between estimated number of dumping sites in the community and the number of times waste is disposed of by household per week. At 95% confidence level and 5% level of significance, there was enough evidence that the number of times of waste disposal by household was highly associated with the number of dumping sites available in the community. In communities, whereas the number of waste dumping site was more than 5, the least number of times household disposed of waste per week was 6 times whereas the maximum was more than 10 times. In a community where the dumping site was only one household the minimum number of times household disposed of waste per week was 1 (once) whereas the maximum was 6–10 times. The above finding means that frequent household waste disposal is highly dependent on the estimated number of waste dumping sites available in the community. In other words, the higher the number of waste dumping sites in the community, the higher the rate of waste disposal by households in the community.

5.3. Distance from collection point to disposal site

Table 7 shows the relationship between number of waste disposal sites and the average distance from the centre of the town.

Table 8 shows the differences in mean regarding diseases that are spread as a result of improper household waste disposal. Findings in the Table 8 indicated that with a high means score of 3.23, the majority of the respondents affirmed that diarrhea is spread as a result of improper disposal of household waste in the community whereas the remaining respondents also identified malaria, and worm infection with means scores of 3.01, and 1.76 respectively.

6. Discussion

The purpose of this study is to assess solid waste management among household in a large Ghanaians district, thus, identifying the adequacy of the communal containers; distance from households to the dumping site and distance from the collection point to the final disposing site in the district.

Urbanization has resulted in increasing waste generation in Ghana. Oduro-Appiah et al. (2019); Miezah et al.,2015). Waste management normally concerns the focused, systematic control of the generation, collection, disposal, processing of waste in a aesthetically regulated, manner (Letcher and Vallero, 2019).

In this current we found that communal waste collection bins were far from household as confirmed by the majority (57.3%) of the respondents. The majority (N = 339) of the households representing 56.5% walked a distance of 11–15 min before reaching the dumping, while others covered a distance of 6–10 min and even more than 15 min before

Table 5. Relationship between distance to waste dumping site and amount paid by household.

Distance	Amount Paid per Month (GHC)				Total	*Chi-square*	*P-value*
	Less than 5	between 5-10	more than 10	NA			
1-5min	0	0	0	15	15	33.527	0.001
6-10min	0	0	27	99	126		
11-15min	8	19	52	260	339		
> 15 min	0	0	34	86	120		
Total	8	19	113	460	600		

Source: Authors Compilation (2018).

Table 6. Chi-Square Computation of the Relationship Between Estimated Number of Dumping Sites and the Number of Times Waste is Disposed by Household Per Week.

Number of Waste dumping Sites	How many times does your household dump solid waste in a week			Total	*Chi-square*	*P-value*
	1-5 times	6-10 times	more 10 times			
1	68	80	0	148		
2	73	231	84	388		
3	0	10	8	18	88.391	0.001
More than 5	0	8	38	46		
Total	141	329	130	600		

Source: Authors Compilation (2018).

reaching the dumping site. This means that household travels a long distance from their place of residence before reaching communal bins to dispose of their waste generated in the house. This finding agrees with Adu-Boahen et al. (2014) who observe this same phenomenon in their study that sought to assess the challenges and prospects with waste management. The long-distance, therefore, discourages some residents, thus they tend to dispose of waste in open drains and indiscriminately in the community. This also compounds the United Nation Conference on Human Settlement observations (UNCHS, 1996) indicating that one third to one half of solid waste generated within most cities in low- and middle-income countries (including Ghana) are not collected. To salvage this situation, it has been opined that each household is required to place a container in front of the house on specific days and collect the container after its content has been collected (Boateng et al., 2019; Francis Xavier et al., 2018).

We found from this study that major type of waste generated by households in the District was plastic and rubbers with a mean score of 4.38. Other types of solid waste generated by households in the district include organic or vegetables, glasses, and ceramics, papers, metals, textiles, and wood. The maximum category of household residents who mostly generate plastics and rubbers was recorded among the self-employed who are mostly traders and the minimum was recorded among farmers. The maximum household respondents that mostly generate organic or vegetable waste was farmers whereas the minimum was recorded among civil servants. This finding supports Ofori (2008) who reported that household solid waste includes plastics, paper, glass, textiles, cellophane, metals and some hazardous waste from household goods such as paint, garden pesticides, pharmaceuticals, fluorescent tubes, personal care products, batteries containing heavy metals and surplus wood treated with unsafe substances Such as anti-fungal and anti-termite chemicals. Similar studies done by Asibey et al., (2019); Abalo et al. (2018) also made the similar observations.

We also found a significance level, there was a significant association ($P \leq 0.001$) between household occupation and the kind of waste generated in the study area. Furthermore, traders and farmers were the major categories of individuals that generate waste mostly. These findings support the view that the quantity and nature of the waste generated vary with the activities and with the level of technological development in a country (Addaney, and Oppong, 2015; Garg, 2012).

The revealed that majority (73.5%) of the households did not sort their waste before disposal. There was enough evidence that sorting of household waste before disposal was highly associated with age and education level of the respondent with probability values of 0.001, and 0.001 respectively. The findings mean that resorting of solid waste before disposal is highly associated with age and educational level of respondents. Individuals who are matured and had higher education stand the chance of sorting their waste before disposing of the waste.

The study found that the number of waste collection point in the community were few (1–3 collection bins) as the confirmed majority (92.2%) of the respondents. Thus, most residents did not have access to waste collections points thereby disposing of waste in open drains. Also, the study showed that the number of times of waste disposal by household was highly depended on the number of dumping sites available in the community. Thus, the frequent household waste disposal is highly dependent on the estimated number of waste dumping sites available in the community. In other words, the higher the number of waste dumping sites in the community, the higher the rate of waste disposal by households in the community. It is for this reason that Anon (2007) and others intimated that in general a single 100-liter bin should be provided for every fifty people in domestic areas, every hundred people at feeding centers and every ten market stalls. Ideally, bins should be emptied daily (Anon, 2007; Alhassan et al., 2017; Samwine et al., 2017), We found that the distance from the center of the community to the final waste disposal site covered 1–2 h journey. We found a significant relationship between the number of waste disposal sites in the community and the average distance (in kilometers one way) from the city center to a disposing site was highly significant ($p \leq 0.001$). It is deduced from the above findings that the higher the number of waste disposal sites, the shorter the average distance (in kilometers one way) from the city center to the disposal site. Household waste is supposed to be collected from the collection point to the final disposal site. In this regard, Tchobanoglous et al. (2013) identified the transfer and transport of solid wastes to comprise two principal steps. That is: (i) the transfer of wastes from the smaller collection vehicle to larger transport equipment; and (ii) the subsequent transport of the wastes, usually over long distances, to a processing or disposal site.

The study found several diseases are associated with improper waste management. This is usually attributed to the fact that choked gutters

Table 8. Diseases caused by improper disposal of waste.

Disease	Mean	N	Std Deviation
Diaarhoea	3.23	296	0.001
Malaria	3.01	259	0.505
Worm Infection	1.76	45	0.515
Total	5.64	600	1.020

Source: Authors Compilation (2018).

Table 7. Relationship between number of waste disposal sites and the average distance from the centre of the town.

No. of Disposal Sites	What is the average distance (in kilometers one way) from the city center to a disposing site?					Total	*Chi-square*	*P-value*
	≤10km	11–20km	21–30km	31–40km	>40km			
None	16	23	1	2	14	56		
2	24	198	79	73	117	491	19.35	0.001
3	4	5	8	7	0	24		
4	0	0	17	0	0	17		
>4	0	0	12	0	0	12		
Total	44	226	117	82	131	600		

Source: Authors Compilation (2018).

often harbor human excreta, stagnant water, and rotten garbage that facilitate the causation and spread of diseases and infections. In this regard, the majority (85%) of the respondents attested that there were diseases recorded recently with regards to improper waste management. Majority of the respondents with a mean score of 3.23 reported that diarrhea was the major disease recorded in the community as a result of improper waste management. Other diseases also recorded as reported by the respondents include malaria and worm infection. To avoid the occurrence of diseases, it is recommended that ideally, bins should be emptied daily to avoid the occurrence of diseases (Anon, 2007; Adzawla et al., 2019).

7. Conclusions

The study was conducted to assess solid waste management among household in a large Ghanaian district. First the study found that communal waste collection bins were far from households. Secondly, number of waste collection point in the community were few. The study found that the distance from the center of the community to the final waste disposal site covered 1–2 h journey.

Fourthly, we found that improper waste disposal has led to poor sanitation resulting in sickness outbreak of diseases such as cholera related diarrhea, malaria and related diseases.

Finally, the study revealed that the provision of trash contains or dustbins at designated points of collection are the most efficient and effective ways of improving the waste management challenge as it will go a long way to improve sanitation.

8. Recommendations

The importance of effective waste management cannot be over empathized. In fact, the most significant reason for waste collection is to protect of the environment in which we leave and the health of the populace. Rubbish and waste is a potential source of air and water pollution. They can generate harmful gases that mix with the air and subsequently cause breathing complications in. people.

Based on the major findings of the study, the following recommendations are suggested for policy planners and policymakers: First, the district assembly should provide waste collection bins to every household to ensure that residents do not dispose of waste indiscriminately.

Second, the residents should be educated on the adverse health and environmental effects of poor waste management; and the need to properly handled and disposed of waste.

Third, there is a need for the government to strengthen district by-laws to ensure proper household waste disposal at all district in Ghana. To this end develop national rules specifically regarding the management of waste and a compulsory and across-the-board systems for tracking its transport, handling and disposal.

Fourth, upgrade and continuously expand waste treatment plants and corresponding disposal facilities such as landfills, systems for waste water treatment among others.

Finally, there should also be the provision of dustbins at key waste collection points. This should be done by consulting all stakeholders such as the various District Assemblies, registered waste management operatives and the members and opinion leaders of the community members themselves.

Declarations

Author contribution statement

Stephen T Odonkor: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Kwasi Frimpong, Napoleon Kurantin: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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