



# The potential, impacts, and challenges of pay-as-you-throw for municipal solid waste services in Ghana

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## ABSTRACT

**Objective:** This study was undertaken to examine the potential of pay-as-you-throw (PAYT) as a cost recovery mechanism, its impacts on solid waste collection services and the challenges associated with its implementation in the Kumasi Metropolis, Ghana. **Materials and Methods:** Data were collected by weighing 262 head-loads of solid waste at communal container sites and recording their corresponding user charges in 14 low and middle-income communities in Kumasi. A household survey involving 80 randomly selected households patronizing communal disposal systems was undertaken to assess their perceptions of PAYT. In-depth interviews with heads of six private solid waste management companies and one with the Waste Management Department of the local authority were also conducted. **Results:** The study showed that the average revenue generated per ton of waste disposed into communal containers was GH¢ 17.07 (US\$11.38). This is 70% higher than the collection fee paid to private waste management companies prior to the implementation of the PAYT. Each communal container accrues an average revenue of GH¢ 153 (≈US\$103) when filled to capacity. However, a significant proportion of residents (80%) claimed not to have been informed about the PAYT mechanism prior to its implementation. Although PAYT has improved service levels due to regular pickup of communal containers, it is confronted with challenges including, inequitable user charges, illegal dumping of waste into communal containers at night; non-payment of user charges; and indiscriminate dumping of waste at unapproved locations. **Conclusion:** PAYT approach has the potential to ensure cost recovery and should be sustained. The local authority need to ensure equitable user charges; allocate buy-back points; undertake intensive public education on the PAYT; and monitor private waste management companies against exorbitant user charges.

**KEY WORDS:** Cost recovery mechanism, municipal solid waste, pay-as-you-throw, solid waste collection

## INTRODUCTION

Municipal solid waste management is among the greatest challenges facing city authorities in the developing world and Ghana is no exception. Owing to rapid population growth coupled with increased economic activities in city centers, huge tons of waste is produced on a daily basis requiring safe disposal [1]. The collection and disposal of the thousands of tons of solid waste generated in city centres constitute a huge drain on municipal budgets. Without any cost recovery mechanism, it is impracticable for city authorities to continually collect and dispose off the enormous waste quantities generated considering other competing demands and services required of them. This has over the past decade necessitated a rethink of the financing mechanism for municipal solid waste services to ensure cost recovery.

Traditionally, the recovery of cost associated with solid waste collection and disposal services has been achieved through property taxes or general taxes over the years. With this approach, proceeds from property taxes and/or general taxes are used to offset the cost of solid waste management services. Residents are therefore not billed for this service independently and generally have no idea how much it costs to collect and dispose of their waste regularly [2,3]. However, the problem is that, it is not possible to exclude from the service those who do not pay because of the benefits of improved health and clean environment associated with the service. This makes it impossible, especially in developing countries, to recover the full cost of solid waste services with taxes. To address this issue, the fixed monthly fee approach, where residents are billed monthly for solid waste management services regardless

of the quantities of solid waste generated and thrown away has been adopted in recent times [4,5]. Yet, this approach also is saddled with numerous challenges thereby making it difficult to achieving the desired results, particularly in the developing world. Apart from non-payment of monthly fees by some users as reported by Ren and Hu [6], other factors such as hidden costs and weak legal mechanisms to recover arrears render this approach ineffective in achieving full cost recovery. Particularly in urban poor communities, the fixed monthly fee approach is an unsuitable option since residents may find it difficult to pay monthly fees for solid waste collection services. The Pay-as-you-throw (PAYT) approach is thus considered as an appropriate option for cost recovery in low-income settings in particular.

PAYT, also known as variable rate pricing, is the practice where users of solid waste services are charged a fee based on the unit quantity (volume or weight) of solid waste they discard [5,7]. This approach combines a fixed and variable fee for a unit residual solid waste disposed of while offering lower or zero charge for recyclables [8]. The basic types of PAYT unit-based pricing mechanisms are weight-based system, volume-based system, frequency-based system, and bag-based system [2,9]. Each of these types is designed based on the basic principle that putting out less solid waste for collection should cost less. This is to provide incentives for recycling and ensure that households generating less waste pay less for waste collection [8,10,11]. PAYT programs are flexible and simple and are being implemented in USA and Europe [9,10]. More countries in Europe are revising their national policy programs to incorporate PAYT as an effective economic instrument for recycling-oriented solid waste management and financing [8]. Across the USA, more than 6,000 communities are using PAYT to manage solid waste [5,7].

Statistics show that, the PAYT has led to the diversion of about 6.5 million tons of municipal solid waste per year that would otherwise have been landfilled in the United States of America [7]. In communities with PAYT, residents have a direct economic incentive to recycle more and to generate less waste [2]. Charging residual waste and offering perceived free-of-charge collection of recyclables provides economic incentives for diverting recyclables from residential waste disposal routes. The diversion of recyclables pays off in a PAYT system as financial savings to the households, and therefore serves as an economic incentive for them [8]. This approach also has the high tendency of causing a change in disposal behavior by ensuring source separation, which promotes recycling efforts [8].

In Ghana, the PAYT system was introduced in 2008 in selected middle - and low - income communities in the Kumasi Metropolitan Assembly (KMA) with the objective of ensuring full cost recovery for solid waste services in these areas [12]. However, little is known as to whether this approach has achieved the desired impact and the lessons that can be learnt to guide replication in other parts of Kumasi and other municipalities across the country. This study seeks to assess the potential of the PAYT as a cost recovery mechanism, its impacts on solid waste collection and the challenges associated with its implementation in the Kumasi Metropolis.

## MATERIALS AND METHODS

The study was conducted in Kumasi; Ghana's second largest city and the capital of the Ashanti Region. It is located about 270 km North West of the national capital, Accra and covers a total land area of approximately 250 km<sup>2</sup>. The city has a population of about two million people with a growth rate more than twice the national average of 2.5%. The Metropolis offers two major solid waste collection services to residents; the house-to-house collection and the communal collection both carried out by private waste management companies, under the supervision of the Waste Management Department (WMD) of the city authority, called KMA. While the former is usually practiced in high income areas, the latter is commonly found in middle - and low - income communities. In areas where communal collection is practiced, attendants at the communal container sites charge residents a discretionary fee for waste disposed of into the communal containers. Eventually, mixed waste from both communal containers and house-to-house collection are disposed of by the private waste management companies at an engineered landfill site. The site is managed by a private company on behalf of the City Authority for a monthly fee based on the quantity of waste tipped at the landfill site, but no tipping fee is charged for waste disposal. The tipping fee is not paid to the company managing the landfill due to the fact that the user charges cover only the collection services. In addition, rummaging is undertaken at the landfill site by waste pickers who subsequently sell the recovered items to recycling companies.

### Data Collection

Data collection for the study was done in 2010 and was comprised of three main approaches; quantification of solid waste disposed of at communal container sites, household surveys and in-depth interviews with heads of six private waste management companies and the WMD of the local authority, KMA.

### Quantifying Solid Waste for PAYT

The total weight of containers containing solid waste prior to emptying into the communal container and the weight of only the containers after emptying into the communal container were determined on site. The weight of solid waste was determined by subtracting the weight of container after disposal from the weight of container and solid waste prior to disposal. A total of 262 randomly selected head-loads of solid waste in 14 communities were weighed with a weight scale. Carriers of these loads were also interviewed using a brief interview guide to obtain information on household size (number of people who generated the waste), duration of waste storage, and frequency of emptying head-loads into the communal containers. The weight of a head-load of solid waste ( $W/kg$ ), the household size ( $H/cap$ ), and the duration of waste storage ( $S/days$ ) were used to determine the daily per capita generation rate ( $P/kg/cap/day$ ) as shown in the formula below:

$$P = \frac{W}{H \times S}$$

The frequency of waste disposal in a month (30 days) for each household (F/head load per household per month) was computed from the duration of waste storage (S/days) by dividing the number of days in a month by the duration of waste storage (S) as per the formula below:

$$F = \frac{30}{S}$$

Based on the user charge per head (U/GH¢) and the duration of waste storage (S/days), the mean user charge per month (C/GH¢) was also computed using the formula below:

$$C = \frac{U}{S} \times 30$$

The mean weight of a head load of solid waste ( $W_m$ /kg) in each community was computed and together with the mean user charge per head load per trip ( $C_m$ /GH¢) in each community, the mean revenue generated per ton of solid waste ( $R_t$ /GH¢ton<sup>-1</sup>) in each community was calculated from the formula below:

$$R_t = \frac{C_m}{W_m} \times 1000$$

The revenue per ton of solid waste paid to private waste management companies was determined from the local authority and compared with the revenue generated from a ton of waste at the communal container site.

A household survey was conducted involving 80 households who patronized the communal collection containers. The 80 residents were randomly selected from the 14 communities where the quantification of solid waste was done. Issues addressed in the survey included an assessment of the level of user involvement in the PAYT system, response to user-complaints, transparency, affordability of user-charges, satisfaction with service quality, and improvements needed.

In-depth interviews involving heads of six private waste management companies and the WMD of the KMA were carried out to obtain comprehensive information on the operation of the PAYT mechanism, its successes, and challenges.

### Data Analysis

Microsoft Excel was used for the analysis of quantitative data on solid waste quantities and revenues generated. A paired *t*-test analysis was applied to determine the statistical significance for the frequency of waste disposal per month and the cumulative monthly user charge per household. The weight of head-loads was also regressed with the user charges to determine their correlation and the statistical significance of the association between them. Moreover, a one-way ANOVA test at 95% confidence interval was conducted to assess statistical significance in the variation

of average per capita waste generation rate among all the study communities. These statistical analyses were conducted using the data analysis tool in Microsoft Excel 2007. Qualitative data from interviews was organized into themes and presented in narrative form.

## RESULTS

### Evolution of Solid Waste Management Financing Strategies in Kumasi

Owing to the rapid population growth in the Kumasi Metropolis over the years solid waste quantities have also increased astronomically. Statistics show that waste generated daily in the metropolis shot up by almost three-fold between 1995 and 2010. This resulted in an increase in solid waste collection costs as well as an increase in infrastructure requirements to adequately manage the waste generated. The WMD of KMA was responsible for waste collection in some part of the metropolis while private companies augmented their efforts. This was the practice until 2008 when solid waste collection was handed over entirely to the private sector with the WMD playing a supervisory role. However, almost 90% of solid waste collection services in the metropolis were by the communal collection method where the local government paid private companies for emptying the communal containers. Residents discarded waste into communal bins to be emptied at no fee while the local government paid a fixed fee of GH¢ 10 (≈US\$7) (1 US\$=1.48 as of June, 2010) per ton of waste collected or GH¢ 50 (≈US\$34) for each 23 m<sup>3</sup> container emptied by the private waste management companies. Payment for solid waste collection services therefore constituted a huge drain on the municipal budget. Huge delays in payment for this service, sometimes running into a year, resulted in private companies also defaulting on their responsibility to empty communal containers in a timely manner causing aesthetic nuisance and insanitary conditions at communal container sites. A rethink of the approach therefore became necessary to reduce the financial burden on the local government.

Consequently, the PAYT mechanism was introduced in 2008 to reduce the expenditure of the local government on solid waste collection services. Charging all users for solid waste collection is the current approach to ensure cost recovery and improved service delivery in Kumasi. This approach recovers part of the monies paid to private companies for emptying communal containers from users. Currently, a subsidy of GH¢ 20 (≈US\$14) per 23 m<sup>3</sup> container (40% of collection cost) is paid to private waste management companies by the KMA while the remaining 60% of collection cost of GH¢ 30 (≈US\$20) is supposed to be collected from users through PAYT charges. The expenditure on solid waste collection services borne by the local government was therefore reduced with the implementation of the PAYT. However, only about half of all the 150 container sites in Kumasi are currently under PAYT. What is left is the promulgation and enforcement of local bye-laws on PAYT to ensure full-scale implementation of this approach.

### Waste Quantities and Revenues Generated from PAYT

Table 1 shows the average revenue generated from fees collected from users at the 14 communal container sites involved in the study. In general, weights of head loads in all the study communities ranged between 2 kg and 21 kg with a mean weight of  $7.07 \pm 3.37$  kg [Table 1]. With the exception of one community; Asem Roman-Hill, all the weights of head loads at the communal container sites in each of the communities were fairly distributed around the mean value as shown by the relatively lower standard deviations. However, the variation of head load per household among the study communities was statistically significant ( $P = 0.04$ ;  $F = 1.83$ ;  $F_{crit} = 1.76$ ) at 5% significance level. Household sizes for the head loads quantified for this study ( $n = 262$ ) ranged between 1 and 11 people with a mean value of  $5 \pm 2$ . Average per capita waste generation rate for all the study communities was  $1.12 \pm 0.43$  kg/cap/day. Statistically, the variation of the average per capita waste generation rate among all the study communities was not significant at 5% significance level ( $P = 0.20$ ;  $F = 1.33$ ;  $F_{crit} = 1.76$ ).

User charges per head load of solid waste ranged between GH¢ 0.1 and GH¢ 0.2 with an overall mean value of GH¢  $0.12 \pm 0.04$  per head load [Table 1]. In terms of weight, this implies an average user fee of GH¢ 0.02 per kg. On the average, about GH¢  $17.07 \pm 2.79$  per ton (mean  $\pm$  standard error) of revenue was accrued for all the study communities. The mean revenue per ton were fairly consistent : ranged between GH¢10.53 and GH¢20.24 ( $\approx$ US\$7-US\$14) with a median of GH¢ 17 (US\$12) per ton.

Assuming an average density of  $400 \text{ kg/m}^3$ , based on estimates by Cointreau [13], in a  $23 \text{ m}^3$  communal container, this implies that each communal container could potentially accommodate about 9 tons of solid waste at full capacity. This translates to an average revenue of GH¢ 153 (US\$103) per communal container.

In general, the frequency of waste disposal at the communal container sites averaged  $23 \pm 9$  head loads per household per month (range = 4-30; median = 30) while the cumulative monthly user charge per household was GH¢  $2.60 \pm 1.1$  (range = GH¢ 0.4-GH¢ 6; median = GH¢ 3). As shown in Figure 1, the frequency of waste disposal has a moderately strong positive correlation (Pearson  $r = 0.74$ ;  $R^2 = 0.55$ ) with the cumulative monthly user charge. This implies that, households which store waste for a longer time (lower frequency of waste disposal) pay less fee for waste disposal in a month and vice versa. A paired  $t$ -test analysis showed a statistically significant difference between the frequency of waste disposal per month and the cumulative monthly user charge per household ( $P = 0.00$ ;  $t \text{ Stat} = 40.49$ ).

A site attendant present at each communal container site is tasked to ensure that users pay the requisite charge (either GH¢ 0.1 or GH¢ 0.2) for dumping into the container depending on the quantity of waste dumped. However, since there are no weighing scales available for weighing the head loads at the sites, user charges are purely discretionary resulting in discrimination.

The effect of this discretionary charging of users by attendants at the communal container sites is clearly depicted in Figure 2. There was an overlap in user charges for head loads between 8 kg

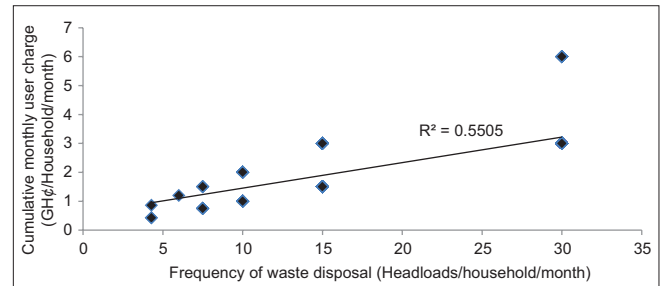


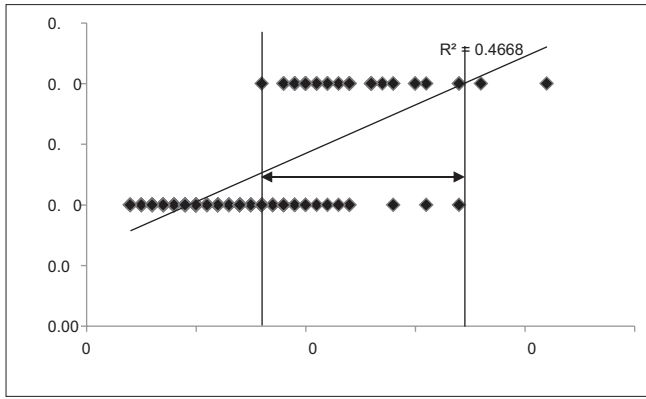
Figure 1: Relationship between frequency of waste disposal and the monthly user charge

Table 1: Revenue generation from PAYT

Study communities	Mean $\pm$ SD			Mean Revenue per ton, $R_t$ (GH¢/ton)
	Weight of head load, $W_m$ (kg)	Per capita waste generation rate (kg/cap/day)	User charge per head load, $C_m$ (GH¢*)	
Tafo Zongo ( $n=20$ )	$7.43 \pm 3.25$	$1.09 \pm 0.33$	$0.12 \pm 0.04$	16.15
Tafo Nkontwima ( $n=20$ )	$9.00 \pm 3.21$	$1.29 \pm 0.48$	$0.13 \pm 0.05$	14.44
Pankrono ( $n=20$ )	$6.45 \pm 2.64$	$1.07 \pm 0.45$	$0.12 \pm 0.04$	18.60
Tafo Ahenbronum ( $n=20$ )	$7.50 \pm 2.49$	$1.05 \pm 0.33$	$0.14 \pm 0.05$	18.67
Ayeduase ( $n=20$ )	$6.03 \pm 2.62$	$1.10 \pm 0.46$	$0.12 \pm 0.04$	19.90
Kotei ( $n=20$ )	$7.43 \pm 3.09$	$1.25 \pm 0.38$	$0.13 \pm 0.04$	17.50
Atonsu MA ( $n=20$ )	$7.50 \pm 3.97$	$1.25 \pm 0.56$	$0.13 \pm 0.04$	17.33
Gyinyaase ( $n=20$ )	$6.88 \pm 3.36$	$0.99 \pm 0.38$	$0.12 \pm 0.04$	17.44
Asafo-Graphic ( $n=20$ )	$5.70 \pm 2.21$	$1.29 \pm 0.47$	$0.11 \pm 0.03$	19.30
Asem-Roman Hill ( $n=20$ )	$7.15 \pm 5.30$	$1.04 \pm 0.34$	$0.12 \pm 0.04$	16.78
New suame ( $n=20$ )	$5.93 \pm 2.42$	$0.95 \pm 0.50$	$0.12 \pm 0.04$	20.24
Old suame ( $n=20$ )	$6.23 \pm 3.74$	$1.02 \pm 0.47$	$0.12 \pm 0.04$	19.26
Bomso ( $n=12$ )	$7.75 \pm 3.09$	$1.19 \pm 0.50$	$0.10 \pm 0.00$	12.90
Old Tafo ( $n=10$ )	$9.50 \pm 3.67$	$1.18 \pm 0.45$	$0.10 \pm 0.00$	10.53
Overall ( $n=262$ )	$7.07 \pm 3.37$	$1.12 \pm 0.43$	$0.12 \pm 0.04$	$17.07 \pm 2.79$

\* Exchange rate: 1US\$=1.48 June, 2010, PAYT: Pay-as-you-throw, SD: Standard deviation





**Figure 2:** Relationship between user charge and weight of head load

and 17 kg resulting in an inequitable charging zone where the same weight of head loads attract rather different user charges instead of same user charges. There is a positive ( $R^2 = 0.467$ ) correlation between the weight of head load and the user charge [Figure 2]. Moreover, regression analysis showed a statistically significant association between these two parameters ( $P = 0.00$ ;  $t \text{ Stat} = 15.09$ ). This is primarily due to the absence of a weight measuring device at the communal container sites and as a result all user charges are at the discretion of the attendants.

### Mechanisms for Revenue Collection from PAYT Charges

Since the introduction of the PAYT approach, the KMA has instituted two different mechanisms for collecting user charges at the communal container sites. One mechanism involves an employee of a private waste management company collecting the user charges at the container site directly for the company. The attendant is paid a fixed salary by the private company on monthly basis for such a service, but the salary is independent of the proceeds accrued from the user charges. Some private companies using this mechanism issue tickets to users for each head load emptied into the containers to ensure that monies collected by the attendants can be accounted for sincerely. On the other hand, a local leader in a community or any resident in a community, acting as an agent, can be contracted by a private waste management company to collect the user charges on its behalf. The agent can in turn hire an attendant to collect the user charges at the communal container sites. A fixed fee is paid by the agent to the private waste management company whenever the communal container is full and any remaining amount of money after payment of this fixed fee becomes the profit of the agent.

### Residents’ Involvement in PAYT and Service Quality Improvements

Results from the household interviews indicate that most residents in the study communities were not consulted for their views before PAYT was introduced. 80% of study respondents claimed not to have been informed about the PAYT before it was implemented. However, about 19% of the respondents claimed they heard it on radio before implementation while only 1% claimed to have been informed by KMA of this initiative. Those

who were informed asserted that vehicles moved round at some locations announcing the PAYT with the aim of informing the communities about its introduction.

When asked about their opinion on affordability of the user fees, half of the study respondents claimed the amount paid was reasonable while the remaining half claimed it was expensive. Moreover, from the survey, 91% of the respondents indicated that they had local leaders in charge of affairs at the community level while the rest claimed to either have no local leaders or had no idea about their local leaders responsible for monitoring service delivery at the community level. Meanwhile, each locality has a leader (typically referred to as an Assemblyman or Assemblywoman) who represents the local authorities in decision-making in the metropolis. Perhaps, a few of these residents are ignorant of their local representatives. When questioned about the type of complaints made to these local leaders, less than a tenth of respondents with knowledge of their local leaders claimed to have made complaints about waste overflows from communal containers, but no immediate action was taken. The rest of them had never made any complaint to any local leader.

From the survey, close to 9 out of 10 (88%) of the study respondents asserted that the solid waste collection service has improved with the introduction of the PAYT while a little more than a tenth (12%) claimed otherwise. Moreover, about two-thirds (61%) of respondents were satisfied with the quality of service while 39% expressed dissatisfaction with the waste collection service. Those satisfied averred that the fencing of communal collection points and the timely emptying of communal containers currently in place make the service better than the situation earlier. They claimed there were delays in the collection of waste and waste spillovers were common prior to PAYT, but the situation has improved after the introduction of the PAYT. Those dissatisfied with the current service expected improvements such as frequent collection of waste and provision of additional communal containers as well as tidy communal collection points. Some expressed the desire for the provision of raised platforms that would enable them access the communal containers easily during emptying of waste since the containers are too high for them while others wanted the communal container sites to be relocated.

Responses from the private waste collection companies indicated that they employed various means to interact with customers to obtain feedback on the level of service from them. The major channel of communication is through the assemblymen. Other means of disseminating information is through the attendants at the container sites. Complaints such as perceived exorbitant rates charged by attendants are reported to the companies’ cashiers who collect the money from site attendants. The poor sanitary conditions at the communal container sites due to waste overflow usually spark complaints from residents as well.

In case of user complaints, the companies make quick follow-up visits to users in order to explain pertinent issues to them. The WMD of Kumasi has also set up a monitoring team which

takes up issues reported to them and resolves them accordingly. This team is, reportedly, almost always moving round the communities where PAYT has been implemented since its main purpose is to create a peaceful atmosphere at collection points as well as ensuring that the duties of contracted private companies are performed well and on schedule.

Site observations by the authors show that there is a remarkable improvement in the solid waste collection service since the companies avoid overflow of waste from containers onto the ground to prevent heaps of ground wastes. This is a great achievement toward service quality and cost recovery and there is evidence of improvements in solid waste collection.

### **Problems Associated With the PAYT and Collection of User Charges**

The implementation of the PAYT mechanism has not yet gained solid grounds in every part of Kumasi despite its potential for cost recovery. It is encumbered by numerous challenges that need to be addressed before it is scaled up to cover the entire city. Some of these challenges as identified from the study are subsequently presented.

**Illegal dumping into containers at night:** The attendants moaned the practice where some residents sneak and dump into the containers at night when they are absent or present but asleep. The idea behind this practice is to evade the user charge and this reduces the revenue eventually accrued although containers are filled to capacity. Other residents also dump waste at dawn (4:00 am) to avoid paying the fee.

**Indiscriminate dumping:** Some residents dump domestic waste into public litter bins and unauthorized places at night in order to evade charges. Others too have resorted to dumping refuse into drains and other open spaces even during the day.

**Reluctance to pay user charges:** Unwillingness of some residents to pay the user charges at the communal container sites was also identified as a key issue. In cases where residents eventually agree to do so, they prefer to pay an amount that suits their interest. This has been the case because most of these defaulters are not abreast with the system of PAYT and are finding it hard to adjust to it. There was little opposition from the people in the communities who do not want to pay and few have resulted to indiscriminate dumping. Such people argued when asked to pay GH¢ 0.2 and rather insisted on paying GH¢ 0.1. There is also non-payment of user charges by some kids. Some users send children as young as 6 years to throw waste without giving them money to pay. Some school children also brought waste from their school to dump for free while others were charged.

**Compaction of waste:** Attendants at the communal container sites claimed that some residents compact their waste and store it for several days before bringing it. This also reflected in the weight of the head load where the higher head-load is charged lower rate by the attendants because of the perceived lower volume due to the compaction.

**Waste from street sweepings waste:** There is also the problem of illegitimate collection of waste from individual homes by some workers of other private companies responsible for street cleaning. The waste from street cleaning and pre-collection was emptied into the communal containers without any payment. The employees involved in street cleaning have unfortunately taken advantage of this opportunity to collect domestic waste from households at a fee, mix them with the street sweepings and eventually empty them into the communal containers at no fee. This practice, the attendants claim, eventually reduces the revenue generated.

### **DISCUSSION**

Outsourcing of solid waste management services to private companies, as currently practiced in the Kumasi Metropolis, is consistent with that reported in other African countries; Ethiopia [14] and Nigeria [15] where local authorities serve as regulators while private companies take up service delivery. In general, private sector participation in solid waste management has been shown to enhance the quality of solid waste management services, reduce the financial burden on municipalities and promote competition [16-18]. The decision by the KMA to involve the private sector can therefore be seen as a step in the right direction. However, regulating the activities of the private sector by the KMA is crucial in this arrangement.

Head loads of solid waste that eventually end up at the communal disposal site is a function of the household size (number of people in a household generating the waste), the income levels of the waste generators and duration of waste storage before disposal. A larger household size coupled with relatively higher income level and longer waste storage periods evidently result in greater quantities of solid waste generated. However, since these parameters are not the same among the study households within the study communities, there was a statistically significant difference in the weight of head loads per household disposed of at the communal container sites. Per capita waste generation rate was however not statistically significant possibly owing to the similar income levels among the study communities. This confirms results in available literature which depict similarity in per capita waste generation for low and middle - income groups [19].

An analysis of the overall mean revenue generated per ton of solid waste for the study communities (GH¢ 17.07 ± 2.79 per ton) shows that this amount is 70% higher than the collection fee of GH¢ 10 (≈US\$7) per ton paid to the private companies by KMA prior to the implementation of the PAYT scheme. Moreover, the average revenue of GH¢ 153 (US\$103) per communal container accrued by the private waste management companies from the PAYT charges is five times higher than the anticipated 60% of total collection cost of GH¢ 30 (US\$20) supposed to be collected from users.

The mechanism therefore proves to be a potential cost recovery strategy for private waste management companies to recover the related costs with solid waste collection services. This is

crucial to ensure sustainability of the service as observed by Ren and Hu [6]. Particularly, this is essential because the local authority; KMA would then be able to progressively wean itself from paying subsidies for waste collection in low- and middle-income communities as it has already done in high income communities. Caution should however be taken to ensure that users are not charged exorbitantly at the communal container sites by attendants when this happens. User fees should be agreed upon among all stakeholders, namely, the KMA, users and private waste management companies/agents. The KMA should constantly monitor private waste management companies to ensure that the terms of the contractual agreements are always adhered to by the private waste management companies and/or agents.

Moreover, the PAYT has the likelihood to ensure the reduction of waste eventually disposed of by households at communal container sites if user fees are adjusted to reflect the quantities of waste. As observed in this study, a weak positive relationship exists between the weight of head loads and the user fees mainly due to discretionary user fees rather than weight-dependent user fees. The absence of a weight measuring device at the communal container sites consequently resulting in discretionary charging poses a huge impediment to ensuring fairness among users as well as reducing waste eventually landfilled. To address this, attendants at the communal container sites need to be provided with weight measuring devices by the private companies or agents and also trained in the use of these devices. User charges can then be set in accordance with the weight of waste disposed of into the communal containers. This means that the shift from volume-based charge to weight-based charging at communal points will remove the inequality of charging based on the discretion of the attendants and volume-based charging. Apart from ensuring equitable user fees, this will compel users to reduce the quantities of waste disposed off and rather consider recovering some items in their waste stream for recycling purposes.

Currently, there is little recovery through informal waste picking and no structured policy and legislation exist to ensure waste reduction at source. Currently, the implementation of the PAYT is aimed at recovering cost of solid waste services. However, when this approach is implemented with intensive recycling programmes, it can provide numerous benefits in the metropolis. As a start, the local authority should set free drop off centres at communal collection points where residents can drop off recyclables for free and eventually reduce their waste disposal charges. Buy-back centres where recovered items can be purchased from residents and subsequently taken to recycling companies can then be introduced with time to motivate residents to recover recyclable materials from their waste streams.

Contrary to the house-to-house collection service where users pay a flat fee on monthly basis for waste collection, as Awunyo-Vitor *et al.* [20] describes, PAYT has the potential to reduce waste disposed of by households and consequently conserve landfill space. Charging a flat fee for any quantity of waste disposed of by residents is evidently not the way to go

if a sustainable waste management approach is envisioned in the long term. Users must be made to reduce waste eventually disposed of by linking the waste quantities disposed of with the user fees. This will promote sorting of recyclable items for sale to recycling companies rather than disposing of anything into the waste stream. Evidence provided by Hall *et al.* [21] indicates that towns and cities implementing variable-rate programs achieve a waste reduction of between 16% and 17% of waste disposed of. Therefore, the PAYT has a two-pronged benefit; recovering costs and reducing landfilled waste. Local bye-laws on environmental sanitation should therefore be reviewed and enforced by the Assembly to reflect current best practices for the realization of the full potential of PAYT.

It is observed from the study that, most of the challenges associated with the PAYT are as a result of the low involvement of residents prior to its implementation. It is evident that community consultative meetings with residents to provide the platform for expression of views during development processes was not given much attention. As established in literature [22,23], community involvement in project planning and implementation plays a crucial role in ensuring sustainability. Perhaps, this would have averted issues of non-payment of user fees, affordability, illegal dumping of waste, free dumping of waste from schools into communal containers, among others. Therefore, it is crucial that the KMA invests in intensive public education and awareness creation to seek inputs from residents both prior to and after implementing the PAYT in the remaining communities and in communities where PAYT is currently in full swing.

Addressing the issue of waste from street sweepings being freely disposed of into communal containers would require that contracts for street sweeping and PAYT in a community are awarded to the same private waste management company. Punitive measures should be instituted for employees found culpable of adding household waste to street sweepings for disposal into communal containers to serve as deterrence.

## CONCLUSION

The PAYT approach has the potential to recover full cost of solid waste collection in low - and middle income areas in the Kumasi Metropolis. Mean revenue generated per ton of waste disposed into communal containers (GH¢ 17.07 ± 2.79) is 70% higher than the collection fee paid to private waste management companies before the implementation of the PAYT. Each communal container can potentially accrue a revenue of GH¢ 153 (≈US\$103) when filled to capacity based on the average user fee per head load of GH¢ 0.12 and an assumed bulk density of 400 kg/m<sup>3</sup>. This provides an opportunity for the local assembly (KMA) to progressively wean itself from paying subsidies of GH¢ 20 (≈US\$14) for each communal container emptied to private waste management companies for communal waste collection in low- and middle- income communities. User charges are however discretionary and shows a weak positive correlation with the weight of head-loads ( $R^2 = 0.47$ ;  $r = 0.68$ ) due to inequitable user charging. Community involvement prior to the

implementation of the PAYT was generally poor and has partly contributed to illegal dumping of waste at night; non-payment of user charges; and indiscriminate dumping of waste into open spaces and drains.

To ensure a successful roll-out of the PAYT city-wide, the KMA should carry out intensive public education of residents in communities where PAYT is in full force and others earmarked for PAYT. User charges must be set in accordance with the weight of head loads and weight measuring devices provided at the communal container sites. This will bring about equitable user charging and promote waste reduction. Communal container sites should be cordoned off and kept under lock and key to prevent illegal dumping of waste into the containers at night. Private companies also need to be monitored consistently by the KMA to ensure adherence to agreed terms of reference for the PAYT to ensure that the approach is sustained in the long term. Buy-back centers and free drop of points for recyclable items must be located at vantage points within the metropolis where these items can be collected and conveyed to recycling companies. This can further generate income for the KMA. Further research is required to ascertain whether the private companies are able to generate enough revenues from the PAYT mechanism to offset the solid waste collection costs and generate profit so that the KMA can in the long run wean itself from paying for waste collection services.

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