Journal of Material Cycles and Waste Management
https://doi.org/10.1007/s10163-024-02068-5

ORIGINAL ARTICLE

Students' perceptions and inclination towards solid waste segregation for circular economy in Krobo municipalities of Ghana: awareness, willingness and potential determinants

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Received: 25 October 2023 / Accepted: 1 September 2024

Abstract

This study assessed students' awareness and inclination towards solid waste segregation for recycling and the potential determinants of student's willingness to participate in waste segregation initiative in the future. The objective was to obtain vital information that can be used in planning for implementation of solid waste segregation for circular economy in schools in the Yilo Krobo and Lower Manya Krobo Municipals in southeastern Ghana. Using semi-structured questionnaire, 1656 students were randomly selected and interviewed across secondary and tertiary schools in the two municipalities for data collection and analysis. Awareness among students about solid waste segregation, including the benefits associated with the practices, was high. Basically, the majority of the students were willing to participate in any solid waste segregation projects in the future if (i) waste bins are located in their classrooms, (ii) clear instruction is indicated on waste bins and/or (iii) students are educated on waste segregation practices. Almost all the students were willing for their schools to pay for collection and recycling of their segregated solid wastes. However, ordinal logistic regression analysis revealed that placing well-labelled waste bins within schools is the most significant determinant to increase students' willingness to segregate wastes for the intended initiatives.

Keywords Educational institutions · Potential factors · Solid waste segregation · Recycling · Circular economy

Introduction

Solid wastes are more rapidly generated in towns, cities, roadsides, market places, lorry stations etc., in Ghana [1–3]. Thus, when they are indiscriminately dumped into the environment with no decisions to separate them for recycling, they often block gutters, waterways and rivers, among others, in towns [1, 4]. Because the quantities of wastes produced in a day across municipalities in Ghana are very huge, solid wastes in choked gutters or waterways contribute to the widespread flooding in some cities and towns in Ghana, whenever there are heavy rains [1]. Moreover, vector-borne and zoonotic diseases have been observed to be associated with accumulation of these solid wastes in districts and municipalities in Ghana [5]. Perhaps, the locations where plastic wastes accumulate may thus become conducive breeding sites for sporozoan-vectoring culicids that are known for transmitting Malaria disease-causing microparasites (e.g., *Plasmodium* spp.) to humans [5, 6].

Although the municipal, the district and/or the metropolitan assemblies, with few stakeholders are making efforts to reduce rapid accumulation of solid wastes in Ghana, management of solid wastes for effective recycling is largely poor across Ghana [7, 8]. According to reports [9–12], municipal solid wastes are disposed of by burning, burying or heaping

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Published online: 16 September 2024

them on rubbish dump ground, whereas household waste or garbage disposal is often by burning. Unfortunately, a decline in birth weight of babies has been associated with exposure of pregnant mothers to incessant solid waste burning [9]. Moreover, other numerous health effects have been linked to the disposal of solid wastes in dump sites, incinerators or other wrong methods in the environment [13]. In effect, the disposal of non-biodegradable wastes extensively pollute the environments, thereby threatening public health across districts or municipalities [1, 5, 9, 10, 13, 14]. Surprisingly, at least 87% of households in Ghana do not think that someone can fall sick of any diseases that can be linked to solid waste accumulation and/or bad waste disposal methods in the environment [10]. In this situation, extensive awareness creation is required to positively change people's perceptions and mindset towards adopting best practices such as solid waste segregation for recycling. This is primarily because solid waste segregation is not widely done by the majority of people in Ghana [15]. Lack of implementation of policy, with the required provisions in cities, towns, public transport hubs and market places, among others, has been one of the major factors limiting waste segregation at household and municipal levels across Ghana [7]. As a result, a mixture of wastes is often collected and heaped at dump sites. Hence, segregation of wastes by individuals is suggested to ease recycling into usable products [7, 16, 17].

Unfortunately, educational status of people has no relationship with failure of a person to segregate wastes into waste bins, although the educated classes of people in Ghana are aware of the need to segregate waste for recycling [7]. In fact, a combination of factors has limited people in doing so [18]. Thus, research is required to investigate perceptions and readiness of people towards achieving sustainable segregation of waste materials for recycling. Here, the aim is to promote circular economy, where several benefits can be realized from waste segregation for recycling [19]. Apart from achieving environmental cleanliness, these benefits can be re-usable items, income and employment for livelihoods, among others. In this case, the long-term success will likely be to meet the requirement(s) for conceptual circular economy.

Based on the fact that the majority of the educated people value the significance of waste segregation for circular economy in Ghana [7], we selected some educational institutions in the Yilo Krobo and Lower Manya Krobo Municipals for a survey about their inclination towards waste segregation. This is because huge amounts of waste generated in educational institutions across Ghana receive no attention for segregation and recycling to achieve circular economy, although recent surveys have revealed that wastes observed in basic, secondary and tertiary schools in Ghana largely constitute the recyclables [20–22]. Therefore, the suggestion will be that each school should supervise effective waste segregation to ease recycling, since the practice is essential for sustainable waste management [16, 17]. Moreover, waste segregation in some selected institutions has mostly served as a model of good lessons to the surrounding communities for effective waste management practice [23].

Unfortunately, to the best of our knowledge, no study has been carried out to examine the readiness of the educational institutions in the Yilo Krobo and Lower Manya Krobo zones in southeastern Ghana. As a result, there is no information with regard to whether schools in these two municipalities will likely embrace waste segregation initiatives on their campuses for recycling or not. Therefore, the current study was carried out in these densely populated municipalities [24]. Our objectives were to assess: (i) levels of awareness and willingness among selected educated respondents in schools about waste segregation for recycling and (ii) potential determinants of waste segregation in these two municipalities. The main aim was to gather sufficient information about the inclination of educational institutions towards segregation of their wastes for effective recycling. In this case, randomly selected students from all the secondary and tertiary schools were the respondents for the survey study. These pieces of information from the students were required to provide guidelines for funded projects intended for implementation of waste segregation and recycling in the two municipalities.

Materials and methods

Chosen study area

The study was conducted in schools in the Yilo Krobo and Lower Manya Krobo municipals (Fig. 1), which are located in the Eastern Region of Ghana. Yilo Krobo Municipal lies approximately between the coordinates (6°00' N, 0°30' W) and (0°30' N, 1°00' W) [25]. To the East, it shares a common boundary with the Lower Manya Krobo Municipal [24], which is located between the coordinates (6.05° N, 0.08° W) and (6.30° N, 0.20° W) [26]. The two municipals cover a total land surface area of *ca*. 821.14 km^2 [24].

Justifications and selected educational institutions

Throwing wastes to the public dump sites, including burning them at household level, is common across municipals [12]. The two municipalities are densely populated [11, 24]. The population density and population of Yilo Krobo Municipal alone are 238 persons km^{-2} and 122,705 persons, respectively [11, 24]. Lower Manya Krobo Municipal has 397 persons km^{-2} and 121,478 persons [24]. In Yilo Krobo Municipal, 7.6% of total enrolments across educational institutions had been the total number of students observed in the

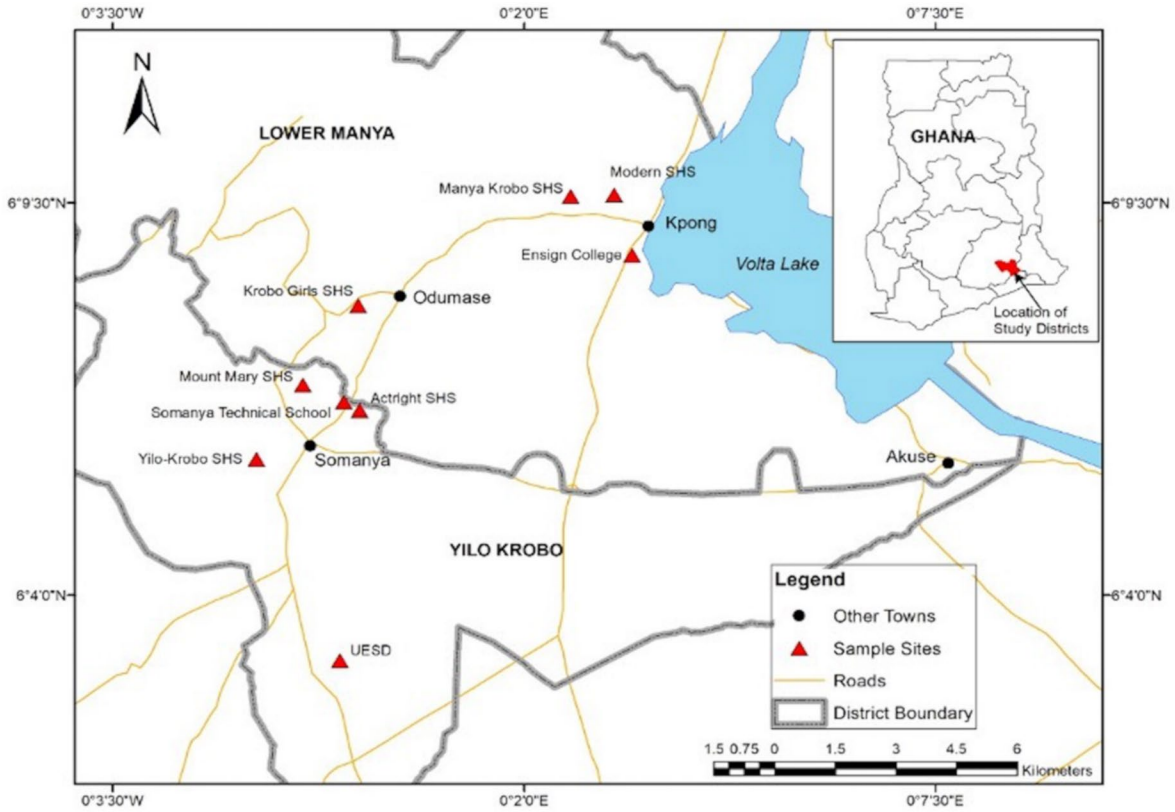

Fig. 1 A map showing Yilo Krobo and Lower Manya Krobo Municipals, with sampling sites in southeastern Ghana. *UESD*: University of environment and sustainable development

senior high schools (SHSs), whereas about 2.1% of summed enrolments across schools represented the total number of students enrolled at the tertiary levels [27]. Similar to the case of Lower Manya Krobo Municipal, about 10.5 and 1.7% of total numbers of enrolled students across schools represented those observed at the SHS and the tertiary levels, respectively [28]. Thus, adequate sample size from these schools can be obtained for surveys. Moreover, according to previous reports [20–22], these educational institutions may likely provide space to cite waste bins for authors' future waste segregation initiative, which was to follow the current survey. Because of these requirements, the two municipalities were considered to be appropriate for the current feasibility survey. Hence, the SHSs and the TIs (in Table 1) were chosen for the survey study.

Sampling

Survey instrument and justification

According to suggestions by reports [29, 30], questionnaires are appropriate to gather relevant information from randomly sampled respondents. Therefore, a semi-structured questionnaire was developed and used to collect primary data for the study. The questionnaire sought to analyze students' awareness and knowledge on waste segregation and recycling. It was designed to also explore behavioral factors that may influence students' perceptions to practice waste segregation for recycling in their schools. Hence, the designed questionnaire was pre-tested to obtain feedbacks from 20 respondents [31]. After that, corrections were made in the questionnaire before it was used to collect data from students.

Data collection

The convenient sampling method, which was based on the assumption of availability of the students at a school was adopted for the interview, similar to the sampling methods used in recent reports [30, 31]. Twenty percent of the enrolled students in each institution were randomly selected and then interviewed. Hence, the sample size from each institution varied (Table 1) according to the Eq. 1:

$$n = \left(\frac{20}{100}\right)N \quad (1)$$

where, n is the total number of students randomly selected for interview in an institution, whereas N is the total enrolment in that institution. In each institution, a coordinator was

Table 1 Detailed information from students' institutions used for this study

Township	Name of the school or the institution	Category of the school	Geographical coordinate for the location of the school	Sample size [§]	
				n	Percentage (%)
Somanya	University of Environment and Sustainable Development (UESD)	TI	(6.050535^0 N, 0.007803^0 W)	31	1.9
Somanya	Mount Mary College of Education	TI	(6.114749^0 N, 0.015951^0 W)	201	12.1
Kpong	Ensign Global College of Public Health	TI	(6.145501^0 N, 0.057277^0 E)	14	0.8
Odumase	Manya Krobo Senior High School (MAKROSEC)	SHS	(5.591377^0 N, 0.249810^0 W)	520	31.4
Odumase	Krobo Girls' Presbyterian Senior High School	SHS	(6.134033^0 N, 0.003993^0 W)	290	17.5
Kpong	Modern Senior High School (MODESCO)	SHS	(6.16222^0 N, 0.053516^0 E)	142	8.6
Odumase	Actright School Complex	SHS	(5.956823^0 N, 0.051325^0 E)	10	0.6
Somanya	Yilo Krobo Senior High School (YIKROSEC)	SHS	(6.098511^0 N, 0.025589^0 W)	411	24.8
Somanya	Somanya Secondary Technical School (SOTECH)	SHS	(6.111749^0 N, 0.006832^0 W)	37	2.2
Total		9		1656	100
			χ^2 -value [#]	1532.1 ********	
			Degree of freedom (DF)	8	
			P-value	$<2.2\times10^{-16}$	

TI Tertiary institution,

SH Senior high school;

[§] Twenty percent of total enrolment from each school (SHS or TI) was sampled for this study;

n Number of students randomly selected and interviewed in the TI or SHS;

[#] Only the numbers of interveiwed students (or respondents) were used for the analysis of goodness-of-fit for equal expectation;

χ2-value Calculated value of chi-square for analysis of goodness-of-fit for equal expectation between educational institutions;

P This is the calculated probability statistic for significance level;

******** indicates significant difference in the distribution of observations between educational institutions at $P \leq 0.00000001$

assisted by 5 to 10 tutors or lecturers, who interviewed the selected students for data collection in 2021–2022 academic year. Thus, the total number of respondents interviewed across institutions in the two municipalities amounted to 1656 (Table 1).

Data analysis

Using the Statistical Package for Social Studies (SPSS. v. 23.0), descriptive statistics were used to examine the data. However, R-software [R.v.4.1.1 and Rstudio.v.1.4.1717] developed by R Core Team [31] was used for chi-square test for analysis of goodness-of-fit for equation expectation between categories. Also, using the R-software, ordinal logistic regression model used in reports of [32, 33] was fitted to data for the pooled numbers of students observed across the institutions in the study area. In this case, 'willingness to segregate waste materials' was the response, whereas each of the several motivational factors was considered to be the predicting variable. According to Eq. 2, the Wald chi-squared statistic (W_i) was assessed [32, 34–36]:

$$W_i = \frac{(\beta_i)(\beta_i)}{(SE_{\beta i})(SE_{\beta_i})} \quad (2)$$

Where, β_i is the coefficient of each predictor, with SE_{β_i} being its standard error. The *P*-value for the significance level of W_i for each predictor was determined, using the assumptions in literature [35–37]. The odds ratio was calculated for each predictor, using Eq. 3 [38, 39]:

$$\text{Odds ratio} = 2.718282^{(\beta_i)} \quad (3)$$

Where, 2.718282 is the value of the constant natural logarithm (e). Based on assumptions [38, 39], the odds ratio was used to determine the predicting variable(s) that will be associated with an increasing effect in students' willingness to segregate wastes.

Results

Distributions of categories of the respondents across institutions

The data gathered from the respondents indicate that 83.6% of them were within the age group of 11–20 years, while those in the range from 21 to 30 years were 15.6%. Nonetheless, only 0.4% of the respondents were observed to be in the range between 31 and 40 years. The age group

of 41–50 years was the least represented by 0.1% of the respondents**.** The majority (i.e. 62.6%) of the respondents were females. Also, the majority of the respondents were teenagers and early adult, thereby, confirming that the respondents were largely at 'senior high school' going age**.**

Awareness and sources of information about waste segregation among respondents

Data on respondents' awareness level about waste segregation have been presented in the Table 2. The majority (71–90%) of the respondents had witnessed waste segregation activities ever before the current study (Table 2). About 27.6% of the students indicated that they had been taught how to segregate wastes for recycling at schools, whereas 18.4% of the students stated that they had viewed a demonstration of the waste segregation on television (TV). About 34.4% of respondents confirmed that they had heard news about waste segregation activities on radios. Meanwhile, 8.2 and 8.6% of these students indicated that they had read news on waste segregation in the magazines and the newspapers, respectively. Unfortunately, only ≤7.9% of these respondents confirmed that they had ever they themselves had segregated wastes in foreign countries for recycling.

Perceived benefits of waste segregation for recycling

From the data gathered, 91–93.3% of the students were aware about recycling of wastes into usable products. In effects, 67–98% of the respondents perceived the benefits that can be observed from waste segregation for recycling (Table 3). Nevertheless, ≤ 22.5% of the respondents in Table 3 were not sure whether such benefits could be realized from waste segregation for recycling.

Willingness to participate in waste segregation initiative in the future for recycling

Among the categories of responses to each of the conditional statement for willingness to participate in any waste segregation initiative in the future, 22.9–49.6% of the respondents would 'strongly agree' to participate (Table 4). Moreover, additional 4.8–9.3% of the respondents would also 'agree' to do so (Table 4), although 14.4–22.9% of these respondents tend to be 'neutral' in their responses to the various conditional statements at the time of this survey (Table 4). Unfortunately, 4.5–38.6% of the respondents stated that they would either 'disagree' or 'strongly disagree' to participate in any waste segregation initiatives in the future (Table 4). However, in the footnote of Table 4**,** between 50 and 57% of

Table 2 In each school, respondents who had ever witnessed waste segregation activities before this study

Name of institution	Category of the school	Categories of response ¶		Total number	Analysis of goodness-of-fit for equal expectation between categories of response		
		Yes	No		χ^2 – value #	DF	*P*-value
University of Environment and Sustainable Development (UESD)	TI	24 (77.4%)	7 (22.6%)	31	9.3226 **	1	0.002263
Mount Mary College of Education	TI	143 (71.1%)	58 (28.9%)	201	35.945 ********	1	$<2.029\times10^{-9}$
Ensign College of Public Health	TI	12 (85.7%)	2 (14.3%)	14	7.1429 **	1	0.007526
Manya Krobo Senior High School (MAKROSEC)	SHS	398 (76.5%)	122 (23.5%)	520	146.49 ********	1	$<2.2\times10^{-16}$
Krobo Girls' Senior High School	SHS	252 (86.9%)	38 (13.1%)	290	157.92 ********	1	$<2.2\times10^{-16}$
Modern Senior High School (MODESCO)	SHS	109 (76.7%)	33 (23.3%)	142	40.676 ********	1	1.797×10^{-10}
Actright Senior High School	SHS	9 (90%)	1 (10%)	10	6.4 *	1	0.01141
Yilo Krobo Senior High School (YIKROSEC)	SHS	323 (78.6%)	88 (21.4%)	411	134.37 ********	1	$<2.2\times10^{-16}$
Somanya Technical School (SOTECH)	SHS	28 (75.7%)	9 (24.3%)	37	9.7568 **	1	0.001787

SHS Senior high school, *TI* = Tertiary institution;

¶ Percentages are indicated in brackets against the observed numbers of respondents for the categories of response;

Only the numbers of interviewed students were used for the analysis of goodness-of-fit for equal expectation;

χ2-value Calculated value of chi-square for analysis of goodness-of-fit for equal expectation between categories of response;

P This is the calculated probability statistic for significance level;

DF Degree of freedom;

*, ** and ******** denote significant difference in the distribution of observations between the categories of response (i.e., 'Yes' and 'No') at $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.00000001$, respectively

Table 3 Perceived benefits of waste segregation for recycling

Statement for the perceived benefits	Categories of response ¶			Analysis of goodness-of-fit for equal expectation between categories of response		
	Yes	No	Not sure	χ^2 – value #	DF	*P*-value
Facilitating waste recycling activities	1418 (85.6%)	86 (5.2%)	152 (9.2%)	2041.9 ********	2	$<2.2\times10^{-16}$
Keeping the environment clean	1616 (97.6%)	31 (1.9%)	9 (0.5%)	3076.8 ********	2	$<2.2\times10^{-16}$
Creating employment for other people	1656 (91.4%)	62 (3.7%)	81 (4.9%)	2791.5 ********	2	$<2.2\times10^{-16}$
Reducing waste to be disposed of at dump sites	1472 (88.9%)	86 (5.2%)	98 (5.9%)	2300.1 ********	2	$<2.2\times10^{-16}$
Reducing environmental degradation	1461 (88.2%)	108 (6.5%)	87 (5.3%)	2245.7 ********	2	$<2.2\times10^{-16}$
Reducing water and sanitation related diseases	1547 (93.4%)	49 (3%)	60 (3.6%)	2690.4 ********	2	$<2.2\times10^{-16}$
Establishing circular economy in my institution	1103 (66.6%)	180 (10.9%)	373 (22.5%)	858.74 ********	2	$<2.2\times10^{-16}$

¶ Percentages are indicated in brackets against the observed numbers of respondents for the categories of response;

Only the numbers of students were used for the analysis of goodness-of-fit for equal expectation;

χ^2-value Calculated value of chi-square for analysis of goodness-of-fit for equal expectation between categories of response;

P This is the calculated probability statistic for significance level;

DF Degree of freedom;

******** denotes significant difference in the distribution of observations between the categories of response (i.e., 'Yes', 'No' and 'Not sure') at $P \leq 0.00000001$

the students will participate in waste segregation initiative for recycling in the future if '*waste bins are located in their classrooms*', '*clear instruction about waste segregation is provided on the waste bins*' or '*each student is educated on waste segregation practices*'.

The determinant(s) of students' willingness to segregate wastes for recycling

The constant was significant at $P < 0.001$ for the model (Table 5). However, only three predictors among the variables were significant at $P < 0.05$ for the model (Table 5). The coefficients of the significant predicting factors were not equal to zero in the ordinal logistic regression model. The three observed significant predictors included '*well-labelled waste bins are located within the schools*', '*verbal reminder for waste segregation is provided*' and '*to promote the image of their school*' (Table 5). Nonetheless, '*well-labelled waste bins are located within the schools*' had an odds ratio, which was slightly larger than 1 (Table 5), whereas the two remaining significant predictors had odds ratio values less than 1.

Willingness to pay for collection of segregated wastes for recycling

About 91.1% of the interviewed students were willing for their institutions to pay for the collection of their segregated wastes for recycling. However, only 67.3% from the 91.1% of students were willing for their institutions to pay charges, ranging from GH¢ 20.00 to GH¢ 50.00 per ton of wastes, to a recycling company for collection and recycling of their wastes. The remaining 23.8% from the 91.1% of the students were willing for their schools to pay charges that are more than GH¢ 50.00 to recycling companies for collection and recycling of a ton of their segregated wastes.

Discussion

In Ghana, previous studies showed that huge amount of wastes can be realized on campuses of educational institutions [20–22]. Moreover, although the views of students in schools from other parts of Ghana could more be informative, we observed that all the categories of respondents from the nine selected educational institutions in the study area were well-representing details across wider geographical area. Therefore, variations in the views of the various groups of students were needed for the success of the intended future waste segregation programmes in the two municipalities in Ghana, where the practice of waste segregation into various recyclable forms is hardly observed [15]. Thus, using schools for the current survey study would provide sufficient information towards planning future waste segregation initiative.

In this study, the majority of the interviewed students in the study area were aware of waste segregation and the benefits associated with the practice. Our observations were in agreement with those in recent report [15], thereby, supporting that people in Ghana are generally aware of the waste segregation practices [8]. However, certain conditional factors could influence people in willing to segregate waste at any locations. In parts of Ghana, [15] observed that

Table 4 Willingness to participate in waste segregation initiative in the future for recycling

Conditional statement for willingness to participate	Categories of response[¶ §]					Analysis of goodness-of-fit for equal expectation between categories of response		
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	χ^2 – value [#]	DF	*P*-value
Waste bins are located in their classroom	491 (29.6%)	109 (6.6%)	239 (14.4%)	79 (4.8%)	738 (44.6%)	943.54 ********	4	$<2.2\times10^{-16}$
Waste bins are located within 100 m from the school	639 (38.6%)	164 (9.9%)	332 (20%)	142 (8.6%)	379 (22.9%)	485.44 ********	4	$<2.2\times10^{-16}$
Clear instruction about waste segregation is provided on the waste bins	394 (23.8%)	94 (5.7%)	276 (16.7%)	129 (7.8%)	763 (46.1%)	877.39 ********	4	$<2.2\times10^{-16}$
Each student is educated on waste segregation practices	405 (24.5%)	74 (4.5%)	254 (15.3%)	101 (6.1%)	822 (49.6%)	1121.5 ********	4	$<2.2\times10^{-16}$
Coloured waste bins are used	557 (33.6%)	136 (8.2%)	320 (19.3%)	106 (6.4%)	537 (32.4%)	550.37 ********	4	$<2.2\times10^{-16}$
Feedback on waste segregation is provided	470 (28.4%)	120 (7.2%)	380 (22.9%)	135 (8.2%)	551 (33.3%)	462.13 ********	4	$<2.2\times10^{-16}$
Written reminder for waste segregation is provided	440 (26.6%)	135 (8.2%)	351 (21.2%)	144 (8.7%)	586 (35.4%)	454.98 ********	4	$<2.2\times10^{-16}$
Verbal reminder for waste segregation is provided	488 (29.5%)	118 (7.1%)	347 (21%)	154 (9.3%)	549 (33.2%)	450.26 ********	4	$<2.2\times10^{-16}$

[¶] Percentages are indicated in brackets against the observed numbers of respondents for the categories of response;

[§] Sum of the boldened percentages for 'waste bins are located in their classrooms', 'clear instruction about waste segregation is provided on the waste bins' or 'each student is educated on waste segregation practices' was between 50 and 57%;

[#] Only the numbers of students were used for the analysis of goodness-of-fit for equal expectation;

χ2-value: Calculated value of chi-square for analysis of goodness-of-fit for equal expectation between categories of response;

P This is the calculated probability statistic for singificance level;

DF Degree of freedom;

******** denotes significant difference in the distribution of observations between the categories of response (i.e., 'strongly disagree', 'disagree', 'neutral', 'agree' and 'strongly agree') at $P \leq 0.00000001$

marital status, income and work experience could have significant influence on willingness of people in segregating wastes in market places. In the current study, the majority of our respondents were largely teenage students who were ≤ 20 year-old. The factors positively influenced the perceptions of more students to willingly segregate wastes on their campuses were identified to be (i) placing waste bins in the students' classrooms, (ii) clear instruction about waste segregation on waste bins and (iii) education to intensify awareness about waste segregation practices. All these significant characteristics of the respondents may be helpful for the success of any future waste segregation initiative in the same schools.

Considering the report of Chen and Lee [18], willingness of people towards solid waste segregation can be linked to attitudinal change in response to change in location of waste bins. In this study, students indicated that they will segregate waste into waste bins if they are located in their classrooms. Nonetheless, the large amount of waste reported on campuses of some schools suggests that classroom space will be disadvantageously inappropriate [20–22]. In this case, increase in quantities of waste across schools will negatively influence students' willingness to segregate a large amount of wastes in their classrooms. Hence, students may be willing to segregate such a huge amount of solid wastes outside classroom spaces, thereby changing the mindset and attitude of students to do so, if waste bins are located within their schools. To examine such an assumption, multifactor models have often been useful to study multiple variables that significantly predict attitude of people for improving management of waste materials in a study area [15, 18, 40]. In Ghana, when Agbefe et al. [15] applied a binomial logistic model to data, marital status, income and work experience

Table 5 Parameters of the ordinal logistic regression analysis for students' willingness to participate in waste segregation (or segregation) programmes across their schools

Predicting factor	Coefficient		Wald statistic		Odds ratio
	β	SE_β	W	P	
Constant	5.07517	0.847851	35.8313 ***	0.0001	160
Making the environment clean and safe	−0.160643	0.151163	1.13	0.2878	0.852
Reducing the cost of waste management for my institution	−0.0004975	0.0578606	7.393×10^{-5}	0.9931	0.9995
Sustainable circular economy	0.0276064	0.0402819	0.47	0.4930	1.028
Well-labelled waste bins are located within the schools	0.0527909	0.0231959	5.18 *	0.0228	1.054
Clear instruction about waste segregation is provided	0.0293272	0.0268665	1.192	0.2749	1.03
I am educated on waste segregation practices	−0.0304688	0.026845	1.29	0.2560	0.97
Colored waste bins are provided	−0.0074013	0.0234481	0.0996	0.7523	0.993
Feedback on waste segregation is provided	−0.005492	0.0288505	0.0362	0.8491	0.995
Written reminder for waste segregation is provided	−0.046614	0.0307384	2.3	0.1294	0.954
Verbal reminder for waste segregation is provided	−0.0655982	0.0273442	5.76 *	0.0164	0.937
Waste bins are located within 100 m from the school	−0.0254069	0.0686392	0.14	0.7083	0.975
Segregated waste are collected segregately	0.0151761	0.0906256	0.03	0.8625	1.015
Segregated waste materials to be recycled would be paid for	−0.005242	0.0800335	0.0042	0.9483	0.995
To promote the image of students' schools	−0.232919	0.0906252	6.61 *	0.0101	0.792
There are buyers for the segregated wastes	−0.0875895	0.0765754	1.31	0.2524	0.916

β Coefficient of each predicting variable;

SE_β Standard error of β;

P: Probability statistic for significance level of Wald statistic (W);

*, ** and *** indicate significance at $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.001$, respectively.

significantly predicted people's willingness to segregate wastes, whereas awareness and age (from 20 to 30 years) were significant predictors of respondents' willingness to pay for collection of wastes. In the current study, ordinal logistic regression analysis revealed that if '*well-labelled waste bins are located within the schools*' rather than in students' classrooms, it will significantly be associated with increasing effect in the willingness of students to segregate wastes.

Also, the majority of the students were willing for their schools to pay for the collection of their segregated wastes for recycling. However, our observations from our ongoing preliminary waste segregation initiative in some schools revealed that waste recycling companies are not currently charging schools to pay for collection of segregated wastes. Rather, these companies are freely supplying toilet tissues (from recycled paper wastes) as a form of reward and motivation to the schools for segregating wastes for recycling. In addition, the waste recycling companies are paying GH¢ 1000 per ton of well-segregated plastic waste materials to schools. Nonetheless, whether waste recycling companies have motivations for schools or institutions are not charged for collection of their segregated wastes, full implementation of our planned initiative for solid waste segregation across schools will examine the roles of waste recycling companies in improving solid waste segregation in the study area.

Conclusions and recommendations

Awareness among students about solid waste segregation for recycling and the benefits associated with the practice was very high. In effect, the majority of the students were willing to participate in any waste segregation initiatives in the future on the conditions that (i) waste bins will be placed in their classrooms, (ii) clear instruction is provided on waste bins and/or (iii) students will be educated on solid waste segregation practices. Almost all the students were willing for their schools to pay charges for collection and recycling of their segregated wastes. However, placing well-labelled waste bins within schools is the most important factor that will increase students' willingness to segregate solid wastes in the future for recycling.

Therefore, we recommend that, as many as possible, waste bins with instructions are placed on campuses of educational institutions to improve solid waste segregation for recycling. Moreover, educating students about the instructions on the various waste bins will improve students' participation in solid waste segregation initiative across schools. However, our observations in this study are limited to perceptions and willingness of educated class of people at secondary and tertiary school levels. Therefore, we suggest similar studies are carried out to examine motivational factors that can sustainably improve solid waste

segregation at basic school, household, and municipal levels for recycling.

Acknowledgements The authors are grateful to all the participating institutions in the Yilo Krobo and Lower Manya Krobo Municipalities. We thank the teachers for assisting the coordinators in the schools during data collection for this study. We remain thankful to the Jospong Environmental Sanitation Research Fund (JESRF) for funding this study through the University of Environment and Sustainable Development (UESD) in Somanya, Ghana. Finally, the authors thank the Vice-Chancellor of UESD for encouraging students and heads of the schools in the study area to segregate solid wastes for recycling.

Author contributions LL, WKH, RA-O, IL, GK-A and MYO-T conceived and designed the research at a meeting; LL, RA-O, IL and MYO-T monitored data collection in the selected schools; LL and WKH analyzed, interpreted the data, discussed findings, reviewed the manuscript, carefully edited it and made valuable inputs; RA-O, IL, GK-A, MYO-T and KSB reviewed the manuscript, carefully edited it and made valuable inputs.

Funding Financial support was by the Jospong Environmental Sanitation Research Fund (JESRF) in Ghana.

Data availability Data are available upon request.

Declarations

Conflict of interest The authors declare that they have no conflicting interest.

Human and animal rights The authors did not use animal or human bodies as objects or materials for this study.

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