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Towards Zero Waste; Assessing Innovative Waste Management Practices in Senior High Schools in Ghana.

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Abstract

Background: *The growing challenge of solid waste management in Ghanaian senior high schools (SHSs) necessitates the exploration of sustainable and innovative practices. This study investigates current waste management approaches in SHSs across Ghana, with a focus on recycling and composting initiatives aimed at achieving zero-waste environments.*

Methodology: *Using a quantitative descriptive survey, data were collected from 420 student leaders across 22 purposively selected SHSs in regional capitals.*

Results: *The findings reveal that 86% of the schools neither recycle nor compost waste, resorting instead to burning or storage for later disposal. Only three schools demonstrated active engagement in innovative waste practices, including plastic recycling and organic composting. Key barriers identified include inadequate waste management infrastructure, lack of segregation, limited student awareness, and insufficient institutional support.*

Conclusion and Recommendation: *Despite high levels of recyclable and organic content in school waste, low technical capacity and minimal governmental intervention hinder progress toward zero waste. The study recommends increased policy integration, capacity-building initiatives, and stakeholder involvement to promote sustainable waste management practices in Ghanaian SHSs.*

Keywords: Innovative, Recycling, Composting, Zero Waste, Initiatives.

Introduction

Solid waste is both organic and inorganic substances produced by the society (Emery et al., 2007). It is unwanted or any material discarded. Solid waste has been increasing on daily basis due to the constant increase in consumption of goods, expansion of production, urbanization and other anthropogenic activities. World Bank Group, (2022) projected the increase of solid waste produced by 2050. Furthermore, the content of solid waste varies and depends on number of factors such as location, season of the year and socioeconomic situation of the original user. The collection, sorting and disposal techniques employed by waste collectors do influence the composition of solid waste. The increase of solid waste generation and poor disposal practices therefore, calls for sustainable waste management practices.

Sustainable solid waste management in all sectors and all corners of a country is very essential. Solid waste management involves the collection, sorting, storage, transfer/transport, processing and final disposal. This must be done in a manner that does not detriment the health of humans and environment. Several researchers (Abanyie et al., 2022; Kwakye et al., 2024; Appiah-Sekyere, 2016) have reported that Ghana faces a huge task in carrying out proper solid waste management. Ghana was once ranked as one of the world's dirtiest countries as reported by Safo-Adu and Owusu-Adzorah (2023). The factors for such rank still persist today as most municipalities still struggle to manage their waste (Appiah-Sekyere, 2016). This situation is not different from educational institutions across the country.

With the advancement and breakthroughs in science, technology and innovation, the crisis in solid waste management in schools still persist. Solid waste management in senior high schools (SHS) has been a major challenging issue in developed and developing countries. This is due to increase in student intake and high consumption in SHS. Ministry of Education, (2018) reported that SHSs are producing high waste due to enrolment increase. Awewomom et al. (2024) attested to the fact that SHS enrolment in Ghana has increased since the inception of Free SHS policy in 2017. Ministry of Education, (2018) reported that the significant amounts of solid waste generated in SHSs

are poorly managed. Siaw (2018) stated that three methods of waste management are practiced in SHSs and theses were open dumping, landfilling and burning. According to Adams (2015) most SHSs schools resort to the use of dumping in pits as a major method of solid waste management.

Obtaining zero waste in SHSs involved using all waste management practices (Alshuwaikhat & Abubakar, 2008), therefore the 5Rs (refuse what you do not need, reduce what you need, reuse, recycle and repurpose waste) in waste management must be deployed to achieve zero waste in schools. Educational institutions are crucial in shaping waste management behavioural patterns to influence the society. To Gottlieb et al. (2012), SHSs are compared to miniature towns due to their size, population and activities that take place there. SHSs have time and spaces for reflecting on waste management practices that are necessary and feasible. Therefore, schools are expected to educate and model sustainable waste management to minimize the effect of poor management of solid waste on their environment (Dery, 2014). Despite SHSs ability to educate and carried out innovative waste management, solid wastes in SHSs are handled poorly and this poses serious health threat to the school environment and the community at large.

Despite the existence of several studies on solid waste management in educational institutions there exist gaps in terms of kinds of studies conducted on solid waste in SHS. Dery (2017) study on institutional solid waste management practices in Ghana and reported poor waste management in several communities. Molina and Catan (2001) revealed that college students in Maigo has a high level of awareness on solid waste management, had good knowledge on segregation, reduction and recycling. Amoah and Addoah (2021) found out that students have enough knowledge in terms on meaning of solid waste, effect of improper solid waste disposal, solid waste prohibited activities, school initiatives towards solid waste, importance of solid waste management and students' responsibilities on waste management. Boateng et al. (2023) study found that both rural and urban senior high schools had waste management practice systems in place but they were dissimilar, however, in both urban and rural senior high schools, the issue of inadequate resources for proper waste management was ubiquitous challenge confronting both set of schools. They further stated that while poor student attitude towards waste management was a major constraint for rural schools, the urban schools had a challenge in terms of poor waste collection routine. The above studies testify to the gaps on studies conducted on solid waste in identifying the innovative waste management practices carried out in SHS. Furthermore, less attention is given to solid waste being generated in SHSs (Boateng et al., 2023). Apart from Boateng et al. (2023); Rojewski (2002) who conducted a study on solid waste management in senior high schools in the Ashanti region of Ghana in terms of practices, improving and challenges, a thorough search of Ghanaian literature did not reveal a study that has been conducted to explore current innovative waste management practices in senior high schools in Ghana. It is against this background this study was conducted to fill the gap. The study therefore sought to explore current innovative waste management practices in senior high schools in Ghana.

Literature

Ghanaian Educational System, Organizational and Institutional Setup

Before the British colonized Ghana, the country was well-known for its apprenticeship education system (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2010) Ghanaians adopted many British practices since they were either directly or indirectly colonized by the British. Ghana's educational system is one example of this; it is based on the British model (UNESCO, 2010). Although it is regarded as one of the best systems in West Africa, it still struggles with high standards of quality and is far from having equal standards throughout the nation (Abdul-Rahaman et al., 2018). The educational system consists of two years and sometimes three years of nursery school, six compulsory years of primary school as well as three compulsory years of junior high school (Free SHS Policy Secretariat, 2018). Students who pass the Basic Education Certificate Examination (B.E.C.E.) are eligible to continue their education for three years at senior high school, which is currently free for all (Baah, 2017). To enter SHS, a student must select schools of choice which is then subjected to computerized placement.

The Computerized School Selection and Placement System (CSSPS) was introduced in Ghana in 2005 to improve the transparency and equity of Basic Education Certificate Examination (BECE) candidates' selection and placement into Second-Cycle Schools (SCSs). The CSSPS aimed to streamline the selection and placement process by reducing human intervention and ensuring a more equitable distribution of students into secondary schools. Before the CSSPS innovation was introduced, heads of very good and highly endowed schools usually called category A and B SHS, unilaterally and indiscriminately set high admission standards and personal cut-off grade points in order to draw in only the most gifted, exceptionally good students and those from rich homes, at the expense of less talented, rural students and those from poor homes. The CSSPS has brought a homogenous component of students in SHS by removing the above personal criteria of selection.

Students who pass the BECE can select from four distinct streams in senior high school: agricultural education, technical education, vocational education, and general courses. The vocational education, agricultural education and the technical education consist of a theoretical part in the classroom as well as on the job training (Asumadu, 2019). Apart from the special subjects there are compulsory subjects during their year's school. Those are mathematics, computer studies, general science, social studies and English. At the conclusion of the three years, all senior high schools in Ghana take the West African Senior School Certificate Examination (WASSCE) as their final exam. Students can enroll in Ghanaian universities and other postsecondary educational establishments after passing the WASSCE exams. To enroll in a university

bachelor's degree program, one must pass the WASSCE (Boateng et al., 2023). A four-year bachelor's degree is followed by a one- or two-year master's program. After that, the student is free to begin their PhD, which, depending on how quickly they work, can be finished in three years or longer (Safo-Adu & Owusu-Adzorah, 2023). Vocational students from SHS or Technical and Vocational Institute (TVI) can enrol in polytechnics. An apprenticeship system is used to arrange this approach (Ampofo, 2020; Aphasia, 2017). In Ghana, polytechnics have been talking to technical universities about changing their two- to three-year curricula to four years (Safo-Adu & Owusu-Adzorah, 2023). Additionally, Ghana has several colleges of education and universities that train teachers. Numerous nursing schools and other specialized institutions can be found all over the nation. New graduates of postsecondary education are required to participate in the National Service Scheme for a year (Amoh et al., 2020). Figure 1 illustrates how long the Ghanaian educational system takes, starting from kindergarten and ending with an undergraduate degree.

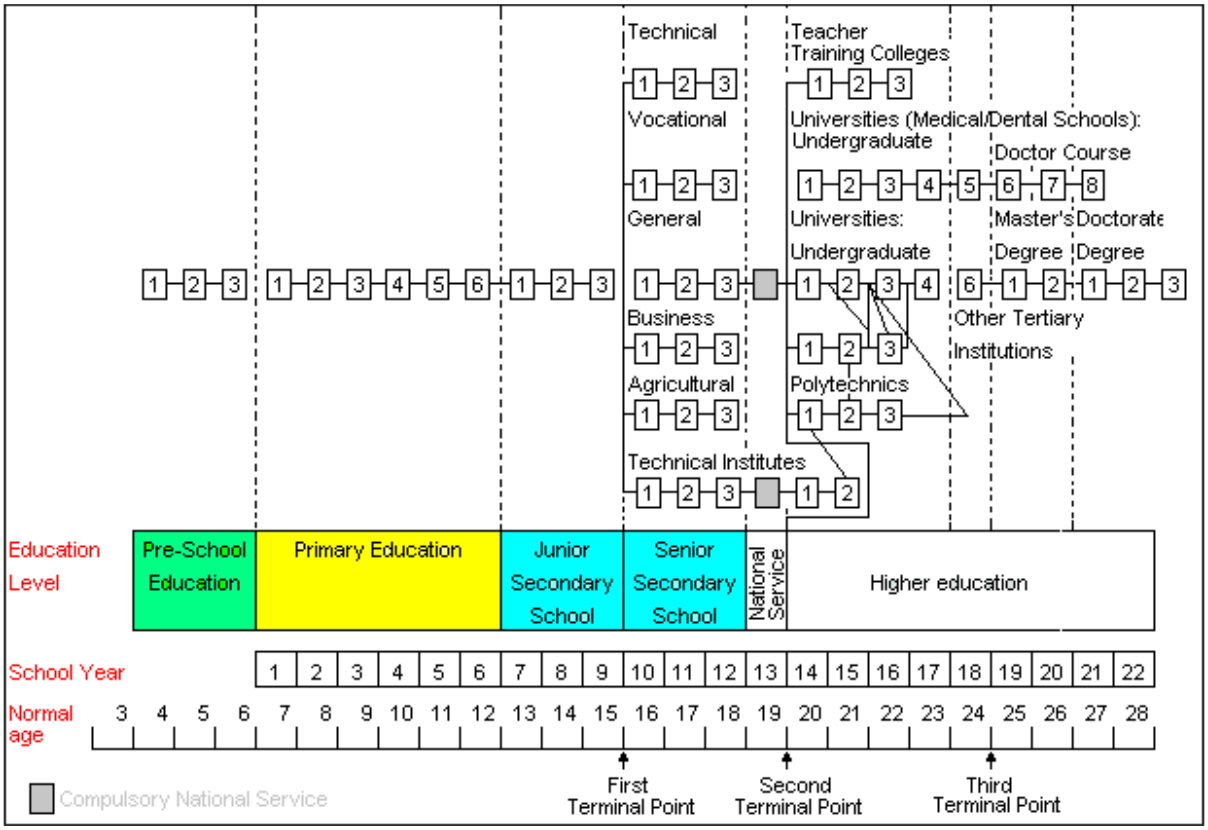

Figure 1: Ghana Educational System Structure
Source: Education structure of Ghana, Wikipedia

The Ghana Education system is governed by the Ministry of Education. The administration and coordination of public education-related initiatives fall within the purview of the Ministry of Education. In collaboration with local authorities (district and regional offices), its various agencies manage the actual implementation of policies. Additionally, the State oversees teacher training. Many private and public colleges prepare applicants to pass the teacher certification exam to teach at certification. Implementation of policies is assumed by its numerous agencies: The Ghana Education Service (GES) is responsible for the coordination of national education policy for pre-tertiary education (Ifegbesan, 2010) and this is done in collaboration with the National Council for Curriculum and Assessment (NCCA), the National Teaching Council (NTC), and the National Inspectorate Board (NIB). In 1974, the Ghana Education Service (GES) was founded as a government agency within the Public Service of Ghana (Kuffour, 2020). Under the forth Republican Constitution of Ghana, these earlier legislations have been amended by Acts of Parliament, including Act 506 (1994) and Act 778 (2008). The GES is controlled by a fifteen-member Council named the GES Council.

In order to support efficient management of the achievement of the Service's objectives and effective teaching and learning, the Ghana Education Service (GES) aims to establish an enabling environment in all educational institutions and management roles. Their goal is to guarantee that Ghanaian school-age children receive high-quality formal education and training by managing resources effectively and efficiently so that the delivery of education is in line with the country's labor demands. In order to guarantee that all Ghanaian children of school age, regardless of their tribe, gender, disability, religious affiliation, or political affiliation, receive high-quality formal education, GES is in charge of carrying out the government's pre-tertiary educational policies (Ugwu et al., 2020; Sangkham & Sangsrichan, 2020).

Ghana's Senior High School Education System

Given Ghana's present demographic shift, SHS development is essential to producing a workforce with a high level of education who are prepared to support the country's growth and utilize its expanding youth population. Expanding fair access to high-quality SHS is especially important for maintaining and enhancing Ghana's standing as a middle-income nation and, consequently, for lowering poverty rates (Awewomom et al., 2024). Senior high schools are designed as part of the basic education system in Ghana's recent educational reform for pre-tertiary institutions. This led to an evaluation and revision of the pre-tertiary curriculum to make it more standard-based. The goal of the standard-based approach is to create well-rounded individuals who possess the information, abilities, values, and skills needed for both self-actualization and the socioeconomic and political reform of the nation (Awewomom et al., 2024).

For students ages 15 to 18, senior high school is regarded as the fifth essential stage of basic education. The SHS program lasts for three years. It offers students the opportunity to specialize in any of the following programs: Science, General Arts, Business, Visual Art, Technical, and Vocational. In a same vein, it is presented as a platform that offers a wide range of academic knowledge and abilities required for admission to international tertiary institutions as well as Ghanaian institutions for further education and training (Awewomom et al., 2024). Thus, after performing exceptionally well on the West African Secondary School Certificate Examination (WASSCE), which is administered by the West African Examination Council (WAEC), SHS graduates have the opportunity to be admitted into universities, polytechnics, and specialized institutions like Nursing Training College, Colleges of Education, and the Military Academy.

Free SHS was introduced in September 2017 as a major reform that is anticipated to solve the sector's equity and access issues, particularly by reducing the costs of SHS, which have been found to be a major deterrent to attendance. Additionally, by guaranteeing that 30% of SHS seats are set aside for students from public JHS, the free SHS policy has advanced the goal of granting admission to prestigious SHS institutions. In order to handle the increasing number of students enrolled in SHS, efforts have also been made in recent years to enhance school infrastructure, especially under the Secondary Education Improvement Project (SEIP). In accordance with article 25 1b of the 1992 Constitution, which states that "Secondary education in its various forms including technical and vocational education, shall be made generally available and accessible to all by every appropriate means, and in particular, by the progressive introduction of free education," the Free SHS sought to make senior secondary school education free and accessible for all students beginning with the 2017–2018 academic year (Adjah, 2012).

Among other things, the Free Senior High School seeks to ensure educational inclusion, especially for the underprivileged in society, by lowering parental financial burdens and improving accessibility in our second cycle schools (UNESCO, 2010). CSSPS and Free SHS have aided in bringing students of diverse backgrounds to various SHS in both urban and rural communities. By 2030, "all boys and girls complete free equitable and quality primary and secondary education leading to relevant and effective learning outcomes," according to Sustainable Development objective (SDG) objective four, target one, this will be achieved. According to UNESCO (2010). the policy allows for free tuition, admission cost, textbooks, library fees, science center fees, and fees for ICT, examination fee, payment of utilities fee, boarding and food. Ghanaians believe that this intervention is a suitable educational strategy for guaranteeing that Ghanaian children receive a quality education. Because it believes the FSHS policy is a suitable way to share the national cake, civil society and the Trade Union Congress (TUC), Ghana, also support the policy, calling it "the most important social intervention program that has been implemented in our country since independence" (Kingful & Nusenu, 2015). However, it's bedevilled with implementation challenges; notably, inadequate infrastructure and Teaching and Learning materials, and some interim interventions such as the Double Tract System of student placement in Senior High Schools (Essuman & Akyeampong, 2011). Aside these challenges are the negligence of the inclusion of solid waste management. The Free SHS policy enrolment came with the absence of provision of waste management facilities to aid proper waste management system. Solid waste management in Ghanaian schools is therefore left to the discretion of the school authorities.

Solid Waste Management in SHSs in Ghana

Solid waste management in schools in Ghana is burdensome. Solid waste management differs from various educational systems (preschool, primary, junior high, senior high and tertiary). There has not been a designated institution assigned to solid waste management in schools in Ghana. The management of the solid waste in schools is based on the internal school arrangement, The problems faced by SHSs in Ghana in waste management are waste collection, segregation, quantification, recycling and composting. Boateng et al. (2023) stated that there are differences in terms of solid management practices in SHSs in Ghana, especially in rural and urban settings. Solid wastes are mostly collected with the usage of dustbins where the schools have and transported by either labourers or students to the final dumpsite. The final disposal site can be a container, landfill sites or a bid dug hole where the waste is burned. Whereas most SHSs in the urban areas have their waste been transported by waste management companies, those in the rural areas are deprived of this advantage. As echoed by Boateng et al. (2023), labourers are mandated to collect and transport waste in urban schools in Ghana. This is not the case for rural schools as juniors are responsible for waste management in terms of collection, transport and final disposal. Furthermore, companies into waste management concentrate on schools in urban areas and support their waste management activities through the supply of dustbins, education, collection, transport and final disposal. The situation is different from rural schools. Such discrepancies are worrying.

In a study conducted by Boateng et al. (2023) on solid waste management practices and challenges in rural and urban senior high schools in Ashanti Region, Ghana. They found out that both rural and urban SHSs had waste management practice systems in place but they were dissimilar. Furthermore, both rural and urban SHSs had differing challenges. As poor waste collection routine was a major challenge for the urban SHSs, rural SHSs had the challenge of poor attitude towards waste management. Ministry of Education, (2018) conducted a study on solid waste characterisation and recycling potential: a study in secondary schools in Kumasi Metropolis, Ghana. Their study found out that the despite the differing daily waste generation levels, waste pattern flow into three schools; Kumasi Anglican Senior High School (KASHS), Kumasi Wesley Girls Senior High School (KWGSHS), and Kumasi Senior High Technical School (KSHTS) was organic (29.0 %), paper (29.0 %) > plastic (18.0 %) > metal (13.0 %) > leather (5.0 %) > glass (4.0 %) > residual waste (2.0 %). Their study further revealed that recyclable waste was about 97% whereas that of organics was 30.0% indicating the potentiality of recycling and composting. However, none of the schools did practice recycling or composting. The study Amedorme and Sakyiama (2014) conducted a study on implications of poor waste disposal management practices on senior high schools within the Wa municipality of Ghana. His study revealed that waste, rubbish, papers, plastic materials were the solid waste generated in the SHSs in the municipality. In addition, there was no segregation of waste and this was attributed to lack of dustbins. The lack of inclusion and making of waste management as a priority in the Free SHSs policy has accounted for high waste generation and poor waste management. The high enrolment of students did not come with a clear policy direction for waste management in SHSs. Furthermore, there is total lack of educational seminars on waste management for students in SHSs. Despite the potential of schools' waste for recyclability and composting, there is no education and training given to schools from governmental institutions and private companies.

Methodology

The quantitative descriptive survey was used to conduct the study. The study concentrated on the major cities, the regional capitals in Ghana (figure 2) since majority of developmental projects in Ghana are centred in the cities. The major cities have exceptionally good schools which are considered as category A schools. The selected places in Ghana were the capital cities in the various regions. The Republic of Ghana is a unitary state divided into sixteen (16) administrative regions. Purposive sampling was used to select schools. In all twenty-two (22) senior high schools were selected. The basis for the selection of schools from the major cities was due to CSSPS and Free SHS which has brought about the diverse nature of students (most gifted, exceptionally good students from rich, middle income and poor homes) SHS in major cities. Three schools from the twenty-two (22) that were into innovative waste management were purposively selected to find out their knowledge on recycling and composting and various recycling initiatives. Purposive sampling was used to select twenty (20) students from the twenty-two senior high schools each. The selected respondents were student leaders in the selected schools. The school leaders include; school prefects, house prefects, sanitary inspectors/prefects, library prefects and others. These prefects were in the final year of SHS. These respondents were selected based on the day to day running of the school activities with school authorities and believed they have much information of various activities going on in the school. Closed ended questionnaire was administered to 420 students to gather information on solid waste management practice and their challenges in schools in Ghana. Secondary data sources included review of journals, reports, articles, books and internet resources that contain information on waste management in schools. Data obtained from the field was be subjected to analysis using the Statistical Package for Social Sciences (SPSS) software (vs22).

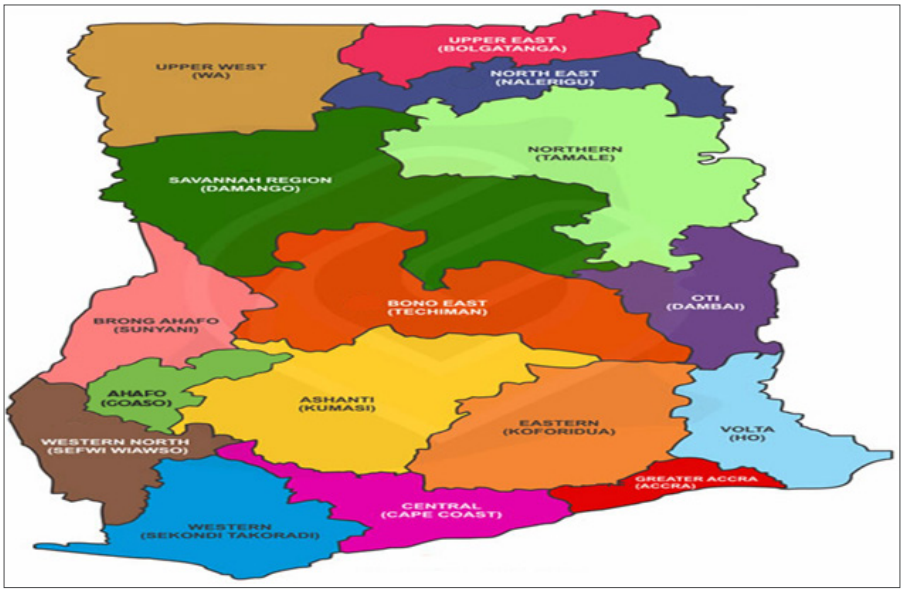

Figure 2: Map of Ghana

Results

Schools Waste Management Practices

From table 1, majority of the schools 19(86%) do not recycle and compost waste produced and resort to either burning or store the large volumes of waste in containers to be picked by institutions involved in the school solid waste management. However, one school do recycling plastic waste and two schools practice composting.

Table 1: Schools waste management practices

Waste management practices	Number of schools	Innovative waste management
Collection and disposal into containers	10(45%)	-
Collection and Burning at created landfill site	9(41%)	-
Recycling of plastics	1(5%)	√
Composting	2(9%)	√
Total	22(100%)	

Challenges of School Waste Management

Respondents were asked about the challenges faced in the school in managing solid waste. From the table below, only few had no challenges with waste management in their schools. Of those who indicated that they had challenges indicated that; lack of waste management facilities and inadequate waste bins of 340(81%), lack of proper segregation practice on the part of students of 34(8%), %), lack of funds and proper management practices of 29(7%) and delay in picking up the waste of 11(3%) (table 2).

Table 2: Challenges of school waste management

Barriers/Challenges In Managing Waste In Schools	Frequency	Percentage
Lack of waste management facilities and inadequate waste bins	340	81%
Lack of proper segregation practice on the part of students	34	8%
Lack of funds and proper management practice	29	7%
Delay in picking up the waste	11	3%
No barriers	6	1%
Total	420	100%

Awareness of Composting and waste recycling initiatives

Three schools were involved in innovative waste management (composting and recycling) as indicated in table 3. Students in these schools involve in composting and recycling were asked about their awareness on composting and recycling initiatives in the schools. From School A, most of the respondents 15(75%) were aware of recycling and 5(25%) were not aware of recycling. From School B, most of the respondents 13(65%) were also aware of composting and 7(35%) were not aware of composting. Lastly, more than two-thirds of the respondents 17(85%) were aware of composting whereas 3(15%) were not.

Table 3: Awareness of Composting and recycling initiatives in the school

School	N(%)
School A (recycling)	
Yes	15(75%)
No	5(25%)
School B (composting)	
Yes	13(65%)
No	7(35%)
School C(composting)	
Yes	17(85%)
No	3(15%)

Knowledge Level on Composting

Most of the respondents from School B said compost takes a lot of time 67%, requires high degree of technical knowledge 62%, takes a lot of effort 68% and takes a lot of space 57% (table 4). This was not different from the responses from School C as most of respondents said compost takes a lot of time 68%, requires high degree of technical knowledge 70%, takes a lot of effort 60% and takes a lot of space 60%.

Table 4: Knowledge level on composting of respondents

School	Parameter N (%)			
	Takes a lot of time	High degree of technical knowledge	Takes a lot of effort	Takes a lot of time and space
School B				
Agree strongly	67%	62%	68%	57%
Undecided	6%	12%	20%	20%
Disagree strongly	27%	26%	12%	23%
School C				
Agree strongly	68%	70%	60%	60%
Undecided	16%	13%	15%	17%
Disagree strongly	16%	17%	15%	23%

Waste Collection and Recycling Initiatives

Respondents from the three schools with composting and recycling initiatives were asked about the means of waste collection and recycling products seen. With that of collection of waste, it is done by placing collection material in and outside classrooms. Greater number of the respondents 48(80%) indicated that collection material was outside classroom, dormitory and dining hall whereas 12(20%) of the respondents indicated that collection material is inside classroom, dormitory and dining hall (table 5). It was observed that the plastics are then burn/melt with an extruder and they then mixed the

melted plastic with sand. Products mostly seen according to the respondents were pavement block 9(45%), slabs of lovers benches 5(25%), plastic furniture 4(20%) and mould bricks 7(35%).

Table 5: Waste collection and recycling initiatives

Parameter	Response	N(%)
Means of waste gathering		
	Collection material outside	48(80%)
	Collection material inside	12(20%)
Recycling initiatives		
	Mould bricks	2(10%)
	Pavement block	9(45%)
	Slabs of lovers benches	5(25%)
	Plastic furniture	4(20%)

Discussion

For a long time, experts have been interested in the way schools view solid waste management. In Ghana, solid waste management in schools is terrible. This affects the wellbeing and security of pupils in educational institutions. Understanding students' opinions and ways of thinking about the environment has been aided by several research conducted over the past 20 years on socio-demographic factors, environmental perceptions, and solid waste management (Kuffour, 2020). Since waste typically remains uncollected in schools, leading to environment deterioration and a risk to public health, the quantity and complexity of solid waste generated in high schools are receiving more attention (Kuffour, 2020). Out of the twenty-two senior high schools in this study, the majority of them—nineteen—do not recycle or compost the waste that was generated. Instead, they either burn the waste or store it in huge quantities to be collected by organizations that handle school solid waste management. The low level of proper waste management in schools in the form of recycling and composting shows the lack of policy direction on waste management in SHSs. In addition, the above situation is attributed to lack of education on recyclability and composting of school solid waste and the lack of knowledge on recycling and composting. Improper waste disposal practices are public health concern. Despite not quantifying the waste but endorsing (Ministry of Education, 2018) study where they reported that there is high recyclable and organic waste materials in solid waste generated in schools in Ghana. The characterization of waste in (Ministry of Education, 2018) was not different from this study. Ministry of Education, (2018) study revealed that recyclable waste in SHSs in the Ashanti Region of Ghana was about 97% whereas that of organics was 30.0% indicating the potentiality of recycling and composting of waste in SHSs. According to Graham (2013), the solid waste produced in Kumasi Metropolis's SHSs is temporarily stored in waste containers without being separated and then disposed-off on landfills and dumpsites without any valuable materials being saved through recycling. Dei Ofori-Attah (2006) affirmed the poor solid waste management practices in schools by stating that solid waste generated in Ghanaian SHSs in Tarkwa Municipality was disposed of using non-sustainable methods like incineration and landfill disposal. It can be concluded that despite few schools beginning to realize the recycling potential in SHSs solid waste, majority of the SHSs still resort to the old poor methods of waste management in schools. Schools that do practice recycling will have reduction in emissions to environment and avoids large volumes of solid waste from being dumped at landfills. This eradicates any public health consequences from poor solid waste management. Regretfully, due to a lack of recycling facilities, Ghanaian schools have not been able to take advantage of these advantages. When given the needed education and training, commitment from the school management with the support of government, the above situation of low recycling and composting initiatives in schools will be a thing of the past.

The challenges blocking effective waste management in this study were lack of waste management facilities and inadequate waste bins, lack of proper segregation practice on the part of students, lack of funds and proper management practices and delay in picking up the waste. In Ghana, waste management has been impeded with several challenges as reported by (Dunne 2005; Awewomom et al., 2024). The challenges reported above are not different to the ones reported in literature. Students possess sufficient information regarding the concept of solid waste, the consequences of improper disposal, activities that are banned with solid waste, school-based initiatives related to solid waste, the significance of solid waste management, and students' duties (Amoah & Addoah 2021). According to Kuffour (2020), despite SHS students been aware of waste problems on their school grounds, the students had poor waste management practices. This according to Kuffour (2020) varied by student age, class, and sex. These challenges faced by schools in this study make it difficult for schools to handle waste properly. Poor waste segregation practices pose a major danger to effective waste management. Comparable to the conclusions of (Akyeampong, 2010; Boateng et al., 2023), they linked students' inadequate segregation practices to their negative attitudes about solid waste management and their inability to develop the basic sense of appropriately disposing of waste in dustbins. According to Boateng et al. (2023), compared to their rural counterparts, urban schools do not face a challenge with regard to waste bin availability unlike rural schools. They went on to say that a common problem facing senior high schools in both urban and rural areas is the lack of funding for efficient waste management. The government has not given waste management in SHSs priority, despite an increase in enrolment and a commensurate rise in waste generation (Boateng et al., 2023) This has resulted in inadequate resources for effective waste management in terms of management facilities and funds lack of funds. These challenges lead to poor waste management practices. Students' health becomes vulnerable to infectious disease in schools where poor solid waste management is done. Three schools were involved in innovative waste management (composting and recycling) in this study. Products from the waste recycling were pavement block, slabs of lovers benches, plastic furniture and mould bricks. Despite high level of recycled content in school solid

waste, the recycled products were not in huge quantity due to low level of recycling capacity of the schools. The products are not on commercial basis but are used by the school. The manner in which solid waste is segregated and characterized determines the level of recyclability and composting ability. According to Amoah and Addoah (2021), students follow appropriate solid waste management procedures for disposal, recycling, reuse, and reduction when given the needed education and training.

In the various schools where recycling and composting are carried out, there was high level of awareness on the two innovative waste management practices. According to Molina and Catan (2021), there is a high degree of solid waste management awareness among Maigo college students. Although the students' awareness of solid waste management had no effect on their disposal habits, it did have an impact on their segregation, reduce, reuse, and recycle practices (Amoah & Addoah 2021). From this study, students indicated that composting is time-consuming, labor-intensive, space-consuming, and demands a high level of technical expertise. In determining whether the compost is ready, time is employed as an independent variable in the composting process. The readiness of compost varies depending on what and how it is intended to be utilized. Aside time, space plays a significant role in a compost pile's ability to hold heat. Though the composition of solid waste was not assessed the idea that three schools were involved in innovative waste management practices indicates that the wastes from the schools had organic composition. Several studies (Rojewski, 2002; Egyir, 2015; Okyere-Darko, 2017) have reported on the composition of solid waste in schools. Forster et al. (2016) subjected the differences in waste composition in schools to different foods consumed by teachers and students, means of disposal and population patterns in the school. According to Osei-Asibey (2015), about 58.0% of the solid waste produced in schools was classified as biodegradable, which includes organic and paper garbage. This means that such waste can be recycled (Appiah-Sekyere, 2016) or be subjected to composting. A greater proportion of respondents stated that waste materials were collected not in a enclosed area like dinner halls, classrooms and dormitories.

Conclusion and Recommendations

The study sought to explore towards zero waste in Ghanaian schools through composting and recycling initiatives. Only three schools were involved in innovative waste management, indicating that SHSs carried out poor solid waste management practices and this has a detrimental effect on the health of the students. The above situation is attributed to factors that impede the proper waste management in schools. These include lack of waste management facilities and inadequate waste bins been the major challenge faced in schools in implementing proper waste management. When the above challenges are addressed many SHSs which get involve in innovative waste management. Students in schools involve in recycling and composting was aware of these initiatives. Recycled products from recycling were pavement block, slabs of lovers benches, plastic furniture and mould bricks. Efforts should be made by government and school management to organize seminars and workshops for students, teachers and administrators to sensitize them on waste problems and their consequences on the students. Also, schools that are into composting and recycling must be encourage and supported to increase production for commercial purpose. Finally, Ghana government and other stakeholders involve in waste management must organize SHSs science fairs on innovative waste management.

Ethics Approval and Consent

Ethical approval was sought from the institutions and respondents used in the study.

Author Contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

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