

EXPLORING SOURCES OF PLASTIC WASTE IN THE COLLEGES OF EDUCATION IN GHANA: THE CASE OF PRESBYTERIAN WOMEN'S COLLEGE OF EDUCATION-GHANA

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ABSTRACT

Plastic waste generation by individuals and households in higher institutions may not be considered as serious crime, but its long-term financial and environmental consequences can be devastating. This study explored the major sources of plastic waste generation in Presbyterian Women's College of Education Settings and their financial and environmental consequences. A seven week cross-sectional survey to identify the sources of plastic waste generation in the college was conducted. Self-reported data on type and quantity of plastic waste generated were gathered from 480 participants using structured questionnaire, interview and inspection of contents of waste bins used by the college community. The quantitative data gathered was analyzed using descriptive statistics and one-way ANOVA. Thematic content analysis technique was applied to the qualitative data. The results of the study revealed that over 88% of the study participants generate plastic waste in the college. The results further pointed to the college departments as the major sources of plastic waste generation in the college (53%). The plastic waste from these sources have contributed to the financial and environmental burden in the college. The ANOVA test results also revealed statistically significant differences in plastic waste generation by households, departments, residential halls and the sales point. The study concluded that the increasing plastic waste generation and its financial and environmental burdens on the college was due to management failure to institute policy framework to regulate plastic waste generation and its disposal in the college. The study recommends that college students should be educated on the need to purchase food items from college canteen in re-usable plastic bowls. In addition, parents should be educated on the need to purchase re-usable food containers for their wards in the college's Demonstration school. Instituting these measures will help reduce the increasing plastic waste generation in the college and consequently lessens the financial and environmental burdens plastic waste generation continues to impose on the college.

Keywords: Plastic waste generation, financial burden, environmental impact, college of education, Akuapem South, Ghana.

1. INTRODUCTION

The increasing consumption of plastics, especially in developing countries, is generating an exponential rise in plastic waste. Plastics are known as synthetic materials produced from organic polymers derived from petro-based chemicals (Manzoor, Sharma, Sofi, & Dar, 2020). The 1940s witnessed the beginning of production of plastics on an industrial scale, and ever since then plastic waste generation has increased (Geyer, Jambeck, & Law, 2017) as a result of increasing global population. In 2019, for example, there was an estimated 7.7 billion people in the world and by 2050, this figure is expected to reach 9.7 billion with food supplies needed globally projected to increase by 50% (Guillard, *et al.* 2018). This growth in global population resulting in increasing demand for plastic is driving force for food production and consequently the increase in plastic packaging materials usage, thus increasing plastic waste.

The global annual plastic waste production figure has reached 381 million tonnes; and this is expected to double by 2034 (Li, & Khanal, 2016). Of this figure the United State alone generates 35.7 million tons representing 12.2% in 2018 (World Bank, 2018; European Commission, 2018; Lau, *et al.*, 2020); and serving as the dominant generator of plastic waste, responsible for almost half of the global total (Lau, *et al.*, 2020). Statistics also shows that EU-27, Norway and Switzerland produced about 24.9 megatonnes of plastic waste (Unuofin, J. O. (2020), but its distribution is difficult to ascertain (Unuofin, 2020). As of 2018, approximately 380 million tons of plastic is produced worldwide each year (Alabi, Ologbonjaye, Awosolu, & Alalade, 2019). Based on this figure, China produces the largest amount of plastic waste (8.82 MMT) by a significant margin, followed by Indonesia (3.22 MMT), the Philippines (1.88 MMT), Vietnam (1.83 MMT), and Sri Lanka (1.59 MMT), which all make the top five (Alabi, Ologbonjaye, Awosolu, & Alalade, 2019).

In sub-Saharan Africa with a population of 1 billion as of the year 2019, the amount of plastic waste generated annually is 17 million tonnes (Ayeleru, Dlova, Akinribide, Ntuli, Kupolati, Marina, & Olubambi, 2020). This plastic waste generation is dependent on many factors like urbanization resulting from increasing population. Currently, the amount of generated plastic waste in sub-Saharan Africa is 180 million tonnes at the rate of 0.5% per capita per day, the amount that is openly dumped is 70% (Ayeleru, Dlova, Akinribide, Ntuli, Kupolati, Marina, & Olubambi, 2020). Drawing example from Nigeria in Sub-Saharan Africa, it is estimated that plastic waste accounts for more than 20% of the municipal solid waste stream (David, & Joel, 2018).

In Ghana's context, studies show that the use of plastics in Ghana cuts across various industries since plastics are integral part of buying and selling process (Bening, Kahlert, & Asiedu, 2022). Plastic packaging constitutes about 26% of the total volume of all plastics used (Drzyzga & Prieto, 2018). For example, packaging drinking water in plastic bottles and plastic sachet bags has become a popular phenomenon in Ghana as most Ghanaian have developed a strong taste for such sachet water since it is portable and can easily be carried from one place to another (Abrokwah, Ekumah, Adade, & Akuoko, 2021). There is also a perception that such water is safer and enriched with adequate minerals than tap water (Abrokwah, *et al.*, 2021).

Plastic packaging materials have now become a much-preferred choice by both producers and consumers due to its light-weight nature, high durability, and ability to store food and prevent it from contamination (Bening, Kahlert, & Asiedu, 2022). Owing to such a high demand for plastics, Ghana currently imports about 10,000 metric tonnes of plastic annually (Tulashie, Boadu, & Dapaah, (2019). As result of this, the country generates approximately 1.1 million tonnes of plastic waste per year. Statistics shows that per capita generation of plastic waste in Ghana stands at 0.016–0.035 kg/person/day (Quartey, Tosefa, Danquah, & Ohrslova (2015), and plastics make up between 89% of the component materials in the waste stream (Okai, 2020). Accra alone generates about 300 metric tonnes of plastic waste daily; and only 5% of this waste is recycled (Mudu, Akua Nartey, Kanhai, Spadaro, Fobil, & World Health Organization, 2021).

Currently, most products are packaged in polyethylene bags which form about 70% of the plastic waste in the municipal waste stream (Kortei, & Quansah, 2016). Studies (Lau, *et al.*, 2020) show that the increasing on-the-go consumption of food and drinks is the driving force behind the surge in single use plastic packaging globally. The use of plastics as food and water packaging has therefore grew to be a key aspect to successful food industries serving fast foods, ready meals, on-the-go beverages and snacks among others (Ncube, Ogunmuyiwa, Zulkifli, &

Beas, 2021). After consuming the food and the water the plastic wastes are discarded indiscriminately thereby littering the whole environment (Nguyen, 2021). Statistics released by the Kumasi Metropolitan Assembly Waste Management Department and other waste management bodies indicate that about 16.5% of waste which is generated daily, are plastic related (KMA, 2010).

As an institution of higher learning, and with increasing enrolment, the students in the colleges of education in Ghana use fast foods, ready meals, on-the-go beverages, snacks and water, besides dining hall food, packaged in single-use plastic containers. This surge in single use plastic packaging has increased plastic waste generation in most colleges of education. This problem has, in recent time, been recognised as a central issue for Management concern in some public colleges of education in Ghana.

In Presbyterian Women's College of Education (PWCE) settings, the financial and environmental impact associated with plastic wastes generation in the college has gained management attention in recent time. In 2020 for example, the college spent not less than 1,549.5 Ghana cedis (GHS) monthly which is equivalent to GHS 18,594 annually in disposing solid waste including plastic waste through contract cleaning services (Financial Officer, PWCE, 2021). Within the period of two years (i.e. 2020 & 2021), the college spent roughly GHS 28,451 in contract cleaning services alone (Financial Officer, PWCE, 2021). To address these sanitation challenges in the college, management has included the sanitation management issues in its 5-Year Strategic Plans (2022-2027). Therefore a research in waste (particularly plastic waste) generation and waste management practices is needed to guide management to develop evidence-based sustainable sanitation policies and programs that can help address the increasing sanitation challenges in the college.

A number of reviews have discussed the challenges presented by the use of plastic waste in higher institutions (Chico-Ortiz, Mahu, Crane, Gordon, & Marchant, 2020). However, none of these reviews has been conducted in the PWCE to assess the plastic waste generation and its financial and environmental impact in the college, thus leaving critical knowledge gap to fill. Previous waste management strategies adopted by the college have many limitations, including lack of managerial skill, lack of technology capabilities, and restricted infrastructure availability, that restrain them from managing plastic waste generation in the college. These provide justification for the present study. The present study therefore explored the sources and types of plastic waste generation in PWCE settings and their financial and environmental impact on the college, and suggests sustainable measures for lessening the impacts.

2. Materials and Methods

2.1 Study Design, Participants and Sample Size

The study was conducted in the Presbyterian Women's College of Education (PWCE) located in the Akuapem South Municipality of the Eastern Region of Ghana. The study adopted mixed methods approach and a cross-sectional survey design to explore the sources of plastic waste generation and its financial and environmental impact on the college. According to (Creswell, 2014) survey is one of the best research designs that provides accurate and current facts through data collection in human contexts. Data was collected from households, students' residential halls, departments and sales points within the college community using structured questionnaire, interview and inspections of garbage bins used by these units.

Waste management aims to create a healthy school environment and school members. Therefore, the participation of school members is very important. Hence, the study

participants in this study included pupils, students, teachers, tutors, food and water vendors, administrative staff, sanitary workers and household heads. The sample for the study comprised participants drawn from the various households, students' residential halls, departments and sales points within the college. The sample size for the quantitative component of the study was 480 and made up of 142 males (29.6%) and 338 females (70.4%). This sample was selected using simple random sampling technique. This selection technique, according to Singh & Masuku (2014), creates a sample that is truly representative of a study population.

The sample size for the qualitative study was 31 participants comprising four (4) college administrative staffs, five (5) teachers from college departments, six (6) households' heads, nine (9) students, five (5) canteen vendors, and two (2) college waste collectors. These participants were selected using purposive sampling techniques. According to Patton (2002), purposive sampling allows a researcher to gather qualitative responses from best-fit participants, which leads to better insights and more precise research results.

2.2 Research Instruments, Data Collection Process and Ethical Consideration

A mixed method approach comprising the use of structured questionnaire and interview were used to collect data from the 480 respondents. The mixed method approach, according to Gutmann & Hanson, (2002), provides a more complete picture by noting trends and generalizations as well as in-depth knowledge of participants' perspectives.

The items on the questionnaire guide were used to gather data on participants' demographic characteristics (sex & age), the type and quantity of plastic waste generated by each sampling unit within the seven (7) week study period, and the waste management practices adopted by each sampling unit as well as the challenges encountered in disposing of the plastic waste they generate. Test item reliability and scale validity were determined using Cronbach's Alpha Statistics which gives the alpha value of .961. The reliability of a study instrument uses alpha Cronbach coefficients, where alpha values of 0.65 to 0.95 are satisfactory and adequate (Chua, 2006 & Taber, 2018).

The interview guide also sought to find out from the study participants the same contents included on the structured questionnaire. Both instruments (questionnaire and the interview guides) were first pilot-tested with 25 non-selected participants who have the same characteristics with the study participants sample to test their reliability and validity. The researcher finally applied item judgment to maximize the clarity, face value and content validity of items on both instruments.

This was followed by administration of the questionnaire to the 480 participants by the researcher, after informed consent was obtained from the participants. Measures and procedures to protect the confidentiality and rights of all participants were strictly applied. For example, to ensure maximum protection of study participants' their personal identity profiles and confidentiality were concealed with pseudonyms.

A seven (7) week survey of plastic waste generation by households, students' residential halls, college departments and college sales points (canteen) was conducted between February 2022 to March 2022. Plastic waste generated were gathered from 19 households pseudonym as A,B,C,D—S; ten (10) departments represented with numbered 1—10; and five (5) students' residential halls labeled as V, W, X, Y & Z, using self-reported structured questionnaire.

The interview sessions were conducted in English at the time and place convenient to the interviewees. Although the questionnaire and the interview were administered mainly in English, periodically, the local dialect of the participants was used to clarify information being communicated when required. Each interview session lasted for fifteen (15) minutes.

To have an in-depth knowledge and understanding of the types of plastic waste generated by each sampling unit, and to validate the participants' responses from the questionnaire and interview, a self-inspection of contents of waste bins use by each sampling unit was also undertaken with the assistance of the two college refuse collectors. Throughout the administration of the research instruments, quality control measures such as the need for independent completion of the questionnaires and freedom of participation or withdrawal from the study were strictly observed. Special efforts were also made to minimize personal and social desirability biases (a tendency to present reality to align with what is perceived to be socially acceptable). For examples, introducing the purpose of the study, establishing rapport, and asking questions.

3. Data Analysis

The data collected were analysed based on the following operational definitions:

3.1 Inclusion and Exclusion Criteria

3.1.1 Inclusion criterion: Throughout this study, plastic waste was operationally referred to any single-use plastic material that is not recycled and ends up in the college's refuse containers and/or refuse dumps is included in the study.

3.1.2 Exclusion criterion: Throughout this study, any single-use plastic waste material that is either generated in the college or brought to the college premises which is not seen/observed is excluded from the study.

In both *inclusion* and *exclusion* criteria, the single-use plastic materials referred to include plastic bottles, pure water sachet rubbers and polythene bags-popularly refer to as 'takeaway'.

3.2 Measure for plastic waste generation

The primary measure for plastic waste generation in the college was defined as the "single use of plastic materials in the college within the seven weeks of the survey. The seven-week plastic waste generation was based on the premise that at least the predominant use of single plastic materials and the plastic waste management situations in the college will have been the same throughout the seven weeks survey period.

3.3 Qualitative and Quantitative Data Analysis

The qualitative data collected using the interview and the self-inspection of contents of the waste bins used by households, students' residential halls, departments and sales point (canteen) were analysed using thematic content procedure outlined in Neuendorf (2018). The themes emerging from the interview engagements and self-inspection of contents of waste bins were categorized as pure water bottles, polythenes (popularly referred to as 'takeaway') and empty pure water sachets. The results of the interview sessions were presented with selected quotes that reflected respondents' common viewpoints cited for more emphases.

The quantitative data collected using questionnaire was analysed using Statistical Package for the Social Sciences (IBM SPSS Inc., Chicago, IL, USA) Version 26. The prevalence of plastic waste generation in the college was determined from the data and presented. The demographic

characteristics of the study participants were analysed to determine the percentage distributions of participants' sex and age in the sample. The plastic waste generated by each sampling unit were sorted out into three (3) categories, namely plastic bottles, 'takeaway' and empty pure water sachets. The resulting categories were analysed to determine the percentage distributions of each category of plastic waste generated by each sampling unit. The results were presented in both tables and charts and then ranked based on percentage weighting of each category of plastic waste in the sample. To determine whether the mean differences in plastic waste generated by each sampling unit are statistically significant, a one-way ANOVA test was conducted and results presented in tables. The intent of the researcher was to use the findings of the quantitative data to explain, improve and generalise the emerging themes and categories from the qualitative findings. According Lobe (2008), the quantitative research results could be used for generalization of qualitative findings.

4. Results

4.1 Demographic Characteristics of the Study Participants

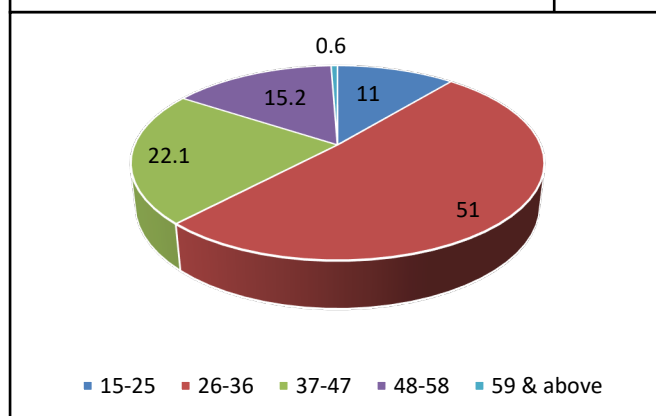
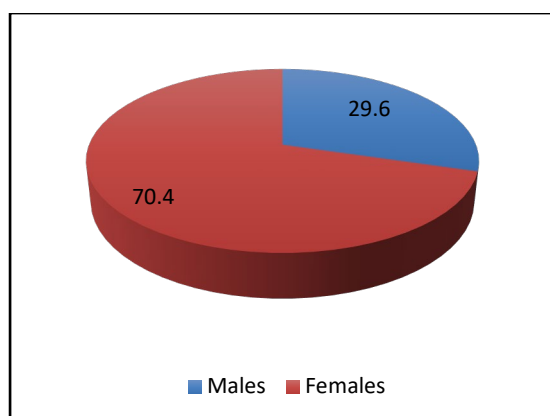


Figure 1: Participants Sex Distribution

Figure 2: Participants Age Distribution

The data presented in Figures 1 and 2 showed that female formed the majority of the study participants and were from the age brackets of 26-36 years.

4.2: Occurrence of Plastic Waste Generation in the PWCE

Table 1: Prevalence of Plastic Waste Generation in the PWCE

| Generates Plastic Waste | Frequency | % Distribution of Choice Categories in Sample |
|-------------------------|------------|---|
| Yes | 426 | 88.8 |
| No | 54 | 11.3 |
| Total | 480 | 100.0 |

Source: Computed from field data 2021, n=480

4.3 The Sanitation and Waste Management Situations in the College

The results of the inspection of waste bins used by the college, households, departments, students' residential halls, and sales points are presented in Plates 1—8 below.



Plate 1: College refuse container/refuse dump



Plate 2: Some plastic waste menace in the college community.

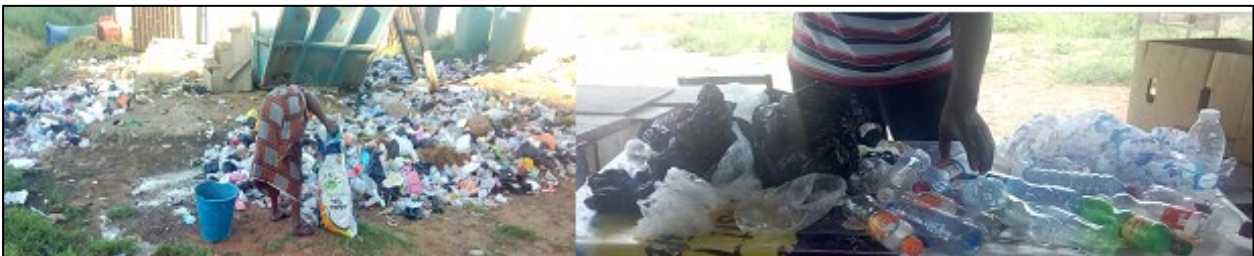


Plate 3: A 43 year old pure water sachet collector gathering pure water sachets on college's refuse dump.

Plate 4: A researcher sorting plastic waste into 3 components.



Plate 5: Households refuse bins overflowing with plastic waste and other waste materials



Plate 6: Some departments and classroom waste bins overflowing with plastic and other waste types(Daily collections)



Plate 7: Some environmental impact of plastic waste in the college.



Plate 8: Some environmental impact of plastic waste generation in the college

4.4 Rank of Plastic Waste Generation in the College by Sources

Table 2: Rank of Plastic Waste Generation in the College by Sources

| Plastic Waste Sources | Plastic Waste Types | | | Total | Percentage Distribution by Sources | Rank By Sources |
|-----------------------|---|--------------------------|--------------------------|---------------|------------------------------------|-----------------|
| | Plastic bottles | Polyethenes ('Takeaway') | Empty pure water sachets | | | |
| | <i>Frequency Distribution of Plastic Waste Generation in Sample</i> | | | | | |
| Households | 381 | 937 | 1004 | 2,772 | 7.1 | 4 th |
| Departments | 1780 | 10455 | 8619 | 20,854 | 53.0 | 1 st |
| Residential halls | 1347 | 4032 | 4422 | 9,801 | 24.9 | 2 nd |
| Sales point | 142 | 1784 | 2187 | 4,113 | 10.5 | 3 rd |
| Homes (Town) | 184 | 1458 | 146 | 1788 | 4.5 | 5 th |
| | | | Total | 39,328 | 100 | |

The top five major sources of plastic waste generation in the college are reported here.

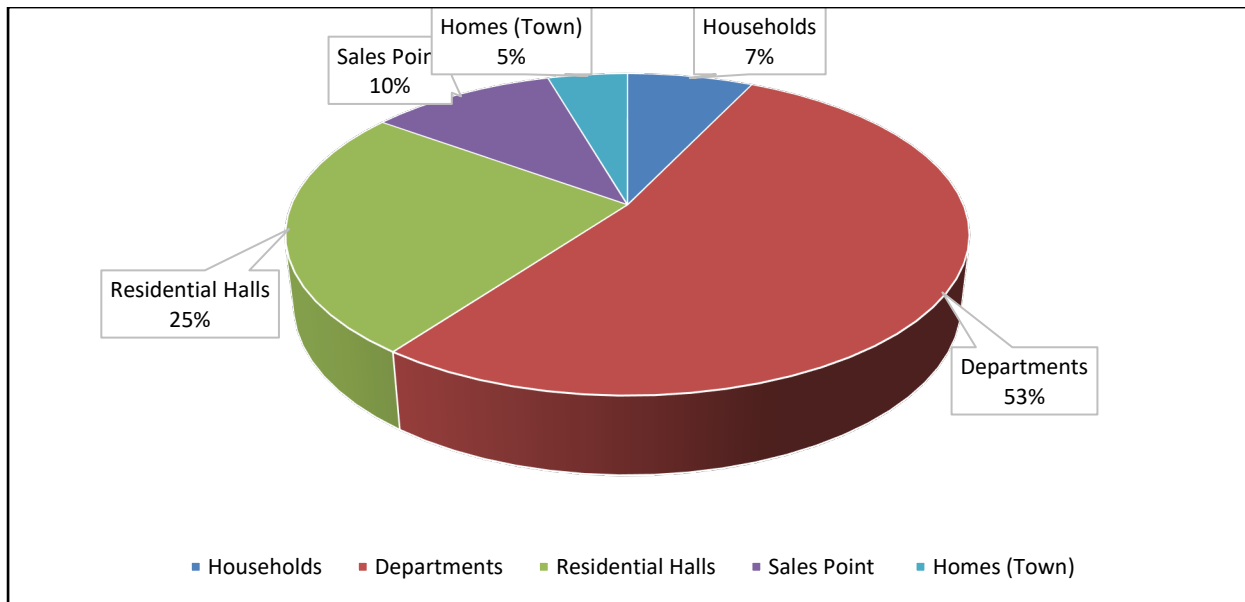


Figure 3: Percentage Distribution of Plastic Waste Types by Sources

As shown in Table 2 and Figure 3, the major source of plastic waste in the college within the seven weeks survey period is the departments accounting for 53% of all the sources revealed by the study.

4.5 Rank of Plastic Waste Generation in the College by Types

Table 3: Rank of Plastic Waste by Types

| Plastic Waste Types | Frequency | | | | | Total | Percentage Distribution in Sample | Rank By Plastic Waste Types |
|--------------------------|----------------|-------|------|------|------|---------------|-----------------------------------|-----------------------------|
| Plastic bottles | 831 | 1750 | 1347 | 142 | 584 | 4654 | 15.6 | 3 rd |
| Polythenes ('Takeaway') | 937 | 10455 | 4032 | 1784 | 1458 | 8666 | 29.0 | 2 nd |
| Empty pure water sachets | 1004 | 8619 | 4422 | 2187 | 346 | 16578 | 55.4 | 1 st |
| | Total = | | | | | 29,898 | 100 | |

Source: Computed from field data 2021, n=480

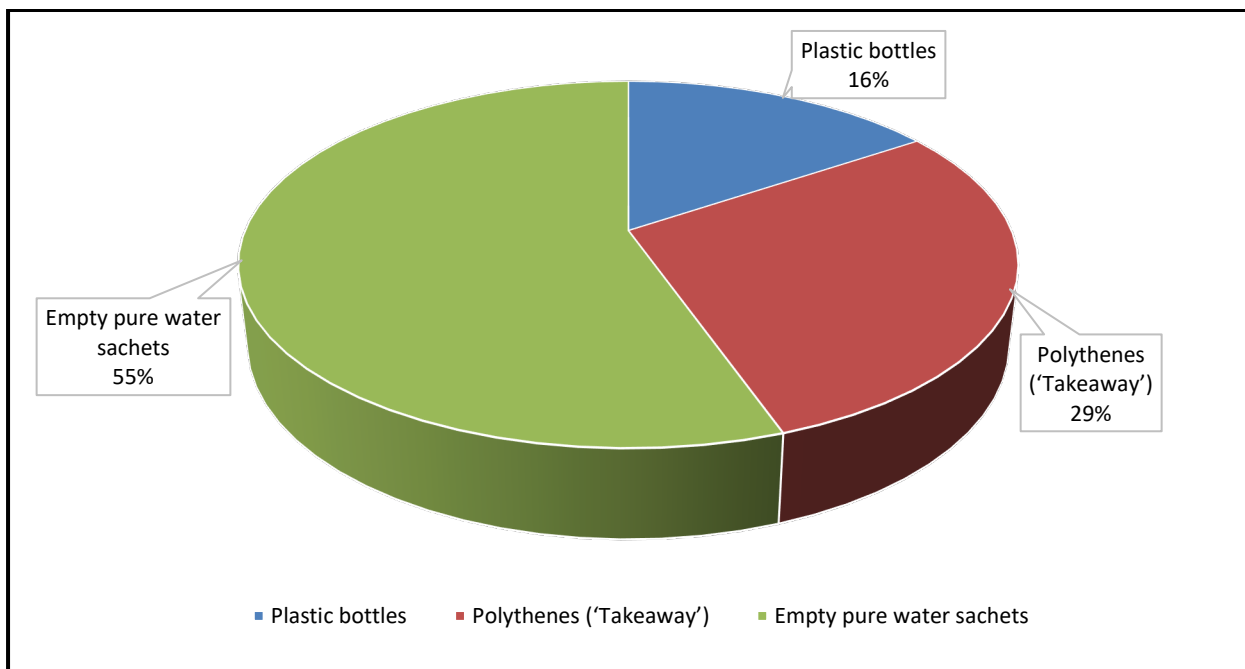


Figure 4: Rank of plastic waste generation in the college by types

Data reported in Table 3 and Figure 4 showed that pure water sachets constituted the main plastic waste generated in the college (55%).

4.6 Rank of Plastic Waste Types Generation by Households

Table 4: Rank of Plastic Waste Generation in the College by Households

| Households (Represented with Letters) | Plastic Waste Types | | | | | |
|--|---------------------|------------------|-------------------|------------------|--------------------|------------------|
| | Pure Water Bottles | | ‘Takeaway’ | | Pure Water Sachets | |
| | % Distribution | Rank | % Distribution | Rank | % Distribution | Rank |
| Household A | 52.0 | 3 rd | 29.6 | 13 th | 18.4 | 17 th |
| Household B | 46.9 | 6 th | 31.0 | 11 th | 22.1 | 14 th |
| Household C | 37.7 | 8 th | 40.2 | 4 th | 22.1 | 14 th |
| Household D | 55.1 | 2 nd | 23.5 | 17 th | 21.4 | 16 th |
| Household E | 31.2 | 9 th | 35.3 | 6 th | 33.5 | 10 th |
| Household F | 25.3 | 11 th | 37.2 | 5 th | 37.5 | 8 th |
| Household G | 24.8 | 12 th | 31.2 | 10 th | 44.0 | 4 th |
| Household H | 22.0 | 17 th | 34.5 | 8 th | 43.5 | 5 th |
| Household I | 11.9 | 19 th | 50.5 | 1 st | 37.6 | 7 th |
| Household J | 23.9 | 14 th | 18.7 | 19 th | 57.5 | 2 nd |
| Household K | 22.8 | 15 th | 34.7 | 7 th | 42.6 | 6 th |
| Household L | 24.8 | 12 th | 40.9 | 3 rd | 34.3 | 9 th |
| Household M | 53.1 | 5 th | 20.3 | 18 th | 26.6 | 12 th |
| Household N | 28.9 | 10 th | 43.8 | 2 nd | 27.3 | 11 th |
| Household O | 53.8 | 3 rd | 29.5 | 14 th | 16.7 | 18 th |
| Household P | 45.9 | 7 th | 32.7 | 9 th | 21.4 | 13 th |
| Household Q | 16.1 | 18 th | 26.3 | 16 th | 57.7 | 1 st |
| Household R | 22.5 | 16 th | 30.3 | 11 th | 47.2 | 3 rd |
| Household S | 60.7 | 1 st | 25.8 | 15 th | 13.5 | 19 th |

Source: Computed from field data 2021, n=480

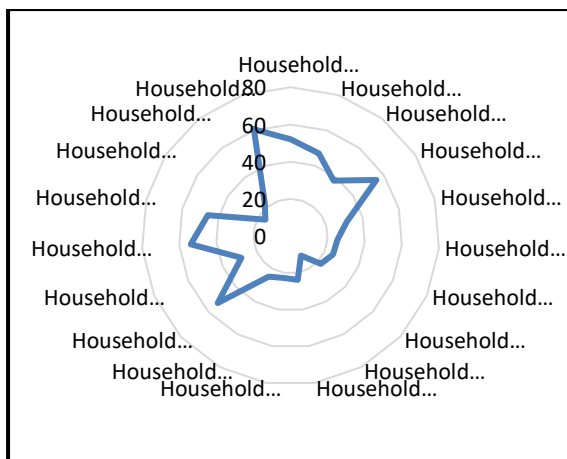


Figure 5: Pure Water Bottles Generation by Households

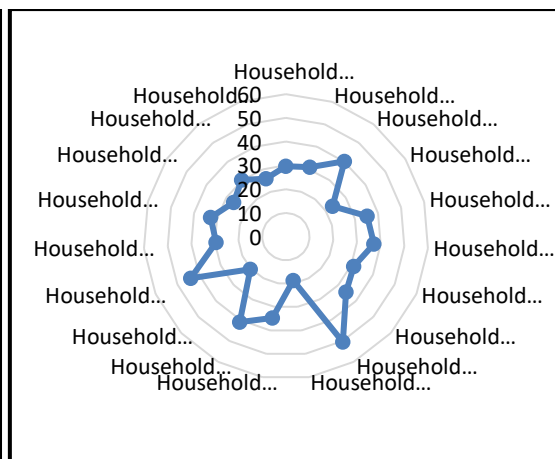


Figure 6: Take-away Polythenes Waste Generation by Households

Data recorded in Table 4 and Figure 5 showed that household ‘S’ generates the most pure water bottles as waste than the other households included in the study. The Table 5 and Figure 6 data also showed that household ‘I’ generates the most pure water bottles as waste than the other college households included in the study.

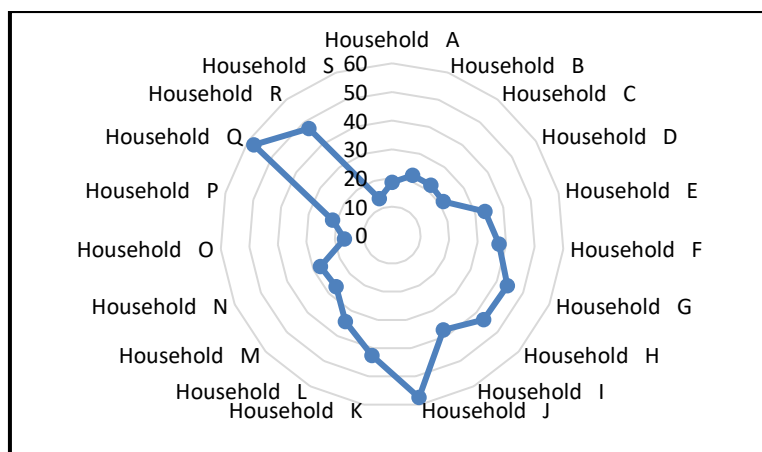


Figure 7: Pure Water Sachets Waste Generation by Households

The data presented in Table 5 showed that the department number 3 generated the largest quantity of 'takeaway' plastic waste compared to other departments. Similarly, departments' numbers 7 and 2, respectively, generated the largest quantities of pure water bottles and pure water sachets in the college. Again, data presented in Table 4 and Figure 7 also showed that household 'Q' generates the most pure water bottles as waste than the other households.

4.7 Rank of Plastic Waste Types Generation by College Departments

Table 5: Rank of Plastic Waste Generation in the College by Departments

| Departments | Plastic Waste Types | | | | | |
|---------------|---------------------|------------------|-------------------|------------------|--------------------|------------------|
| | Pure Water Bottles | | 'Takeaway' | | Pure Water Sachets | |
| | % Distribution | Rank | % Distribution | Rank | % Distribution | Rank |
| Department 1 | 19.6 | 9 th | 29.2 | 3 rd | 51.1 | 3 rd |
| Department 2 | 24.2 | 4 th | 12.8 | 10 th | 63.0 | 1 st |
| Department 3 | 3.5 | 10 th | 43.4 | 1 st | 53.2 | 2 nd |
| Department 4 | 19.7 | 8 th | 29.2 | 4 th | 51.2 | 4 rd |
| Department 5 | 19.9 | 7 th | 33.2 | 2 nd | 46.9 | 8 th |
| Department 6 | 22.3 | 5 th | 27.1 | 6 th | 50.6 | 6 th |
| Department 7 | 40.8 | 1 st | 22.4 | 7 th | 36.7 | 9 th |
| Department 8 | 22.2 | 6 th | 27.2 | 5 th | 50.6 | 5 th |
| Department 9 | 32.1 | 3 rd | 17.9 | 9 th | 50.0 | 7 th |
| Department 10 | 33.1 | 2 nd | 22.6 | 8 th | 45.2 | 10 th |

Source: Computed from field data 2021, n=480

The data presented in Table 5 showed that the department number 3 generated the largest quantity of 'takeaway' plastic waste compared to other departments. Similarly, departments' number 7 and 2, respectively, generated the largest quantities of pure water bottles and pure water sachets in the college.

Table 6: Rank of Plastic Waste Generation in the College by Students' Residential Halls

| Students Residential Halls | Plastic Waste Types | | | | | |
|----------------------------|---------------------|-----------------|-------------------|-----------------|--------------------|-----------------|
| | Pure Water Bottles | | 'Takeaway' | | Pure Water Sachets | |
| | % Distribution | Rank | % Distribution | Rank | % Distribution | Rank |
| Hall V | 13.7 | 3 rd | 40.3 | 5 th | 46.0 | 3 rd |
| Hall W | 14.5 | 2 nd | 43.8 | 1 st | 41.7 | 5 th |
| Hall X | 11.7 | 5 th | 40.4 | 4 th | 47.8 | 1 st |
| Hall Y | 13.0 | 4 th | 40.8 | 2 nd | 46.3 | 2 nd |
| Hall Z | 15.9 | 1 st | 40.5 | 3 rd | 43.5 | 4 th |

Source: Computed from field data 2021, n=480

The data presented in Table 6 showed that the students' residential hall Z generates the largest quantity of plastic bottles (15.9%). The hall 2 also generates the largest takeaway plastic rubbers (43.8%). Also, the most pure water sachet rubbers was generated by hall X (47.8%).

4.8 ANOVA Test Statistics of Plastic Waste Generation by Households, Departments, and Students Residential Halls

The one-way ANOVA test statistics of plastic waste generation by households, departments, and students' residential halls are presented in Tables 7, 8, and 9, respectively, below.

Table 7: ANOVA Test Statistics of Plastic Waste Generation by College Households

| Households (Pseudonym with Letters) | | Sum of Squares | df | Mean Square | F | p-value |
|-------------------------------------|----------------|----------------|-----|-------------|---------|---------|
| Household A | Between Groups | 40.569 | 1 | 40.569 | 149.760 | .000 |
| | Within Groups | 33.319 | 478 | .271 | | |
| | Total | 73.888 | 479 | | | |
| Household B | Between Groups | 56.479 | 1 | 56.479 | 429.883 | .000 |
| | Within Groups | 14.583 | 478 | .131 | | |
| | Total | 71.362 | 479 | | | |
| Household C | Between Groups | 47.531 | 1 | 47.531 | 253.382 | .020 |
| | Within Groups | 22.510 | 478 | .188 | | |
| | Total | 70.041 | 479 | | | |
| Household D | Between Groups | 50.777 | 1 | 50.777 | 371.788 | .000 |
| | Within Groups | 13.111 | 478 | .137 | | |
| | Total | 63.888 | 479 | | | |
| Household E | Between Groups | 79.790 | 1 | 79.790 | 444.838 | .008 |
| | Within Groups | 27.982 | 478 | .179 | | |
| | Total | 107.772 | 479 | | | |
| Household F | Between Groups | 134.047 | 1 | 67.024 | 252.332 | .000 |
| | Within Groups | 101.200 | 478 | .266 | | |
| | Total | 235.247 | 479 | | | |
| Household G | Between Groups | 99.605 | 1 | 99.605 | 508.586 | .043 |
| | Within Groups | 42.303 | 478 | .196 | | |
| | Total | 141.908 | 479 | | | |
| Household H | Between Groups | 78.773 | 1 | 78.773 | 362.875 | .000 |
| | Within Groups | 42.982 | 478 | .217 | | |
| | Total | 121.755 | 479 | | | |
| Household I | Between Groups | 34.889 | 1 | 34.889 | 138.906 | .041 |
| | Within Groups | 48.225 | 478 | .251 | | |
| | Total | 53.114 | 479 | | | |
| Household J | Between Groups | 77.406 | 1 | 77.406 | 619.938 | .000 |
| | Within Groups | 16.482 | 478 | .125 | | |
| | Total | 93.888 | 479 | | | |
| Household K | Between Groups | 44.542 | 1 | 44.542 | 252.006 | .030 |
| | Within Groups | 17.498 | 478 | .177 | | |
| | Total | 62.040 | 479 | | | |
| Household L | Between Groups | 46.875 | 1 | 46.875 | 192.398 | .000 |
| | Within Groups | 32.891 | 478 | .244 | | |
| | Total | 79.766 | 479 | | | |
| Household M | Between Groups | 45.402 | 1 | 45.402 | 109.431 | .052 |
| | Within Groups | 58.500 | 478 | .415 | | |
| | Total | 103.902 | 479 | | | |
| Household N | Between Groups | 42.132 | 1 | 42.132 | 177.925 | .000 |
| | Within Groups | 29.836 | 478 | .237 | | |
| | Total | 71.968 | 479 | | | |
| Household O | Between Groups | 29.261 | 1 | 29.261 | 148.682 | .024 |
| | Within Groups | 14.957 | 478 | .197 | | |
| | Total | 43.218 | 479 | | | |
| Household P | Between Groups | 42.130 | 1 | 42.130 | 224.788 | .000 |
| | Within Groups | 17.992 | 478 | .187 | | |
| | Total | 60.122 | 479 | | | |
| Household Q | Between Groups | 59.714 | 1 | 59.714 | 458.810 | .000 |
| | Within Groups | 17.570 | 478 | .130 | | |

| | | | | | | |
|-------------|----------------|--------|-----|--------|---------|------|
| Household R | Total | 77.284 | 479 | | | |
| | Between Groups | 61.132 | 1 | 61.132 | 292.688 | .000 |
| | Within Groups | 29.241 | 478 | .209 | | |
| Household S | Total | 90.373 | 479 | | | |
| | Between Groups | 36.541 | 1 | 36.541 | 329.816 | .010 |
| | Within Groups | 9.639 | 478 | .111 | | |
| | Total | 46.180 | 479 | | | |

The ANOVA test results captured in Table 7 above showed statistically significant difference in means plastic waste generated by college households ($p < 0.05$).

Table 8: ANOVA Test Statistics of Plastic Waste Generation by College Departments

| Departments/Units | | Sum of Squares | df | Mean Square | F | p-value |
|-------------------|----------------|----------------|-----|-------------|--------|---------|
| Department 1 | Between Groups | .905 | 1 | .905 | 3.668 | .056 |
| | Within Groups | 117.992 | 478 | .247 | | |
| | Total | 118.898 | 479 | | | |
| Department 2 | Between Groups | 6.997 | 1 | 6.997 | 8.867 | .003 |
| | Within Groups | 377.201 | 478 | .789 | | |
| | Total | 384.198 | 479 | | | |
| Department 3 | Between Groups | 2.536 | 1 | 2.536 | 12.440 | .000 |
| | Within Groups | 97.455 | 478 | .204 | | |
| | Total | 99.992 | 479 | | | |
| Department 4 | Between Groups | .972 | 1 | .972 | 4.053 | .045 |
| | Within Groups | 114.620 | 478 | .240 | | |
| | Total | 115.592 | 479 | | | |
| Department 5 | Between Groups | .912 | 1 | .912 | 3.762 | .053 |
| | Within Groups | 115.919 | 478 | .243 | | |
| | Total | 116.831 | 479 | | | |
| Department 6 | Between Groups | 2.428 | 1 | 2.428 | 11.401 | .001 |
| | Within Groups | 101.803 | 478 | .213 | | |
| | Total | 104.231 | 479 | | | |
| Department 7 | Between Groups | 3.280 | 1 | 3.280 | 4.539 | .034 |
| | Within Groups | 345.368 | 478 | .723 | | |
| | Total | 348.648 | 479 | | | |
| Department 8 | Between Groups | 3.432 | 1 | 3.432 | 5.654 | .018 |
| | Within Groups | 290.160 | 478 | .607 | | |
| | Total | 293.592 | 479 | | | |
| Department 9 | Between Groups | 1.933 | 1 | 1.933 | 5.472 | .020 |
| | Within Groups | 168.859 | 478 | .353 | | |
| | Total | 170.792 | 479 | | | |
| Department 10 | Between Groups | 2.796 | 1 | 2.796 | 6.462 | .011 |
| | Within Groups | 206.796 | 478 | .433 | | |
| | Total | 209.592 | 479 | | | |

Mean difference is significant at $p < 0.05$

Table 9: ANOVA Test Statistics of Plastic Waste Generation by Students' Residential Halls

| Students Residential Halls | | Sum of Squares | df | Mean Square | F | p-value |
|----------------------------|----------------|----------------|-----|-------------|-------|---------|
| Hall V | Between Groups | 1.327 | 1 | 1.327 | 5.376 | .021 |
| | Within Groups | 117.998 | 478 | .247 | | |
| | Total | 119.325 | 479 | | | |
| Hall W | Between Groups | .972 | 1 | .972 | 4.053 | .045 |
| | Within Groups | 114.620 | 478 | .240 | | |
| | Total | 115.592 | 479 | | | |
| Hall X | Between Groups | .993 | 1 | .993 | 3.995 | .046 |
| | Within Groups | 118.873 | 478 | .249 | | |

| | | | | | | |
|--------|----------------|---------|-----|-------|-------|------|
| | Total | 119.867 | 479 | | | |
| Hall Y | Between Groups | 1.217 | 1 | 1.217 | 4.936 | .027 |
| | Within Groups | 117.864 | 478 | .247 | | |
| | Total | 119.081 | 479 | | | |
| Hall Z | Between Groups | 1.059 | 1 | 1.059 | 4.657 | .031 |
| | Within Groups | 108.732 | 478 | .227 | | |
| | Total | 109.792 | 479 | | | |

Mean difference is significant at $p < 0.05$

The ANOVA test results reported in Tables 7, 8, & 9 showed statistically significant differences in means plastic waste generation by households, departments and students residential halls ($p < 0.05$). These results suggested that there was sufficient evidence to conclude that the generation of plastic waste by households, departments and students residential halls are independent of each other.

4.9 Interview Results

The results of the interview with the household heads, administrative staffs, teachers, students, canteen vendors and college waste collectors are presented below. From the interview, four major themes were evident. These included: (I) Plastic waste created (II) Plastic waste as a resource (III) Plastic waste as landfill materials and (IV) Plastic waste management challenges.

I. Common narratives that relate to plastic waste generation

"In my household, we generate plastic waste like polythene bags, pure water sachets rubbers."

"We drink pure water and the empty sachets are the waste we generate."

"We produce pure water sachets, 'takeaway' polythene bags."

"Specifically, in my household, we consume bottled water and this formed the plastic waste we make."

"Most college students prefer buying food in 'take away' bags to plastic bowls and consume them at their own convenient place and time."

"Most often, school children come to school with food items such as koko, ice kenkey, tea, cooked rice, biscuits, wakye, bread, pure water in takeaway rubbers."

"Most often, school children come to school with food items such as koko, ice kenkey, tea, cooked rice, biscuits, wakye, breade, pure water and soft drinks and other beverages in plastic containers."

"The households, residential halls, departments and college canteen generate more pure water sachets and 'takeaway' polythene bags more than the plastic bottles; we observe these when transferring the refuse from the smaller wheelless refuse bins used by some households, residential halls, departments and college canteen."

II. Common narratives that relate to plastic waste as a resource

The common opinions expressed by most interviewees reflected in the following quote:

"I collect the used pure water plastic bottles and use them as pito containers after thorough washing and disinfection." The empty plastic bottles contribute significantly to the profit I make from daily sales because I don't buy new bottles."

"Water sachets, and polythenes generated are sold to waste collection vendor." The vendor buys them weekly at a meagre price and sell them to recycling company."

"The empty plastic bottles are given to pito vendor for re-use after thorough washing."

"Some members of my household also use the waste polythene bags popularly called 'takeaway bags' to start coalpot charcoal fires."

"I collect the pure water sachets and sold them to a man who comes from Accra every Saturday to buy them."

III. Common narratives that relate to used plastic as landfill materials

The common opinions expressed by most students reflected in the following quote:

“We purchase food items like wakye, koko, rice, kenkey, fried yam, fruits, kebabs, pure water, first among others, from the canteen in take away rubbers; ..after eating, the take away rubbers are deposited in the classroom dustbins which are later thrown into the college refuse bins”. “Each Senior Administrative Staff consumes at least three bottles of pure water daily; whilst the Junior Administrative Personnel, however, use sachet water and each takes at least five sachets of pure water daily”.

. “Each Senior Administrative Staff consumes at least three bottles of pure water daily; whilst the Junior Administrative Personnel, however, use sachet water and each takes at least five sachets of pure water daily; the plastic waste generated after consuming the water are collected by office cleaners daily and deposited into the college refuse containers.”

“We produce pure water sachets, takeaway’ polythene bags; ...my household dispose of these into the college refuse collection bins; ...some household members sell pure water to students and I think the students damp the empty sachets into college’s dustbins.”

The common views expressed by the teachers mirrored the following:

“During break periods, it is not uncommon seeing students coming to classrooms with food items comprising ice kenkey, cooked rice, biscuits, soft drinks, wakye, breade, pure water and fried yam etc in polythenes bags.”

IV. Common narratives that relate to plastic waste management challenges

The general views of the two casual waste collectors and finance officer reflected the following:

The common opinions expressed by the waste collectors is seen in the narrative below.

“The household waste bins are small and usually overflow as refuse are deposited in them. The college refuse bin are also small and sometimes both students and school pupils are forced to throw the waste outside the refuse container when it is full to capacity; during the time of carrying the college refuse away to landfill site by contract service provider (Municipal Assembly), we collect the refuse or waste deposited outside into the container again-very worrying, tedious and time consuming”.

Again, the sentiment expressed by the finance officer also resonated the following.

“The sanitation challenges in the college is alarming. For example, within the period of three years (i.e. 2019, 2020 & 2021), the college spent almost GHS 52,963 on both sanitation materials and contract cleaning services. This is equivalent to over 98% of total sanitation revenue generated by the college within the same period.”.

5. DISCUSSION

The study explored the major sources of plastic waste and their financial and environmental consequences in Presby Women’s College of Education Settings. The results of the study revealed that over 88% of the study participants generate plastic waste in the college (Table 1). The results further pointed to the college departments as the main sources of plastic waste in the college (Table 2 & Figure 3).

Also, ranking the plastic waste generation by type within the college departments (Table 3), it was obvious that the college Department 7 generates the largest quantity of plastic bottles with percentage point of 40%; Department 3 generates the largest amount of polythenes (takeaway’ bags) also with a percentage point of 43.4%; and department 2 leading the pure water sachet waste generation with percentage point of 63%. In the case of the students’ residential halls, the students’ hall Z topped the production of pure water bottles (15.9%), hall W leading the production of polythenes (takeaway bags) (43.8%) and the hall X also topping the creation of pure water sachet waste (47.8%). One-way ANOVA test results revealed statistically significant difference in means plastic waste generation by college departments and students’ residential halls ($p < 0.05$).

The main vehicle accounting for this are the Demonstration school pupils, particularly the JHS category, and the college students. The pupils either brought food from homes or bought food on their way to school in single-used plastic materials such as ‘takeaway’ bags (See Plate 2). After consuming the food, the ‘takeaway’ polythenes are considered as landfill materials and therefore thrown into the college refuse bins. These findings were echoed by most of the teachers interviewed from the Demonstration school. They said:

“Most often, pupils come to school with food items such as koko, ice kenkey, tea, cooked rice, biscuits, wakye, bread, pure water, soft drink and other beverages in ‘takeaway’ plastic carriers; these takeaway carriers are thrown into the college refuse bins.”

Similar culture was also observed among the college students. The common views they expressed during the interview engagements resonated the following:

“We purchase food items like fruits, wakye, koko, cooked rice, kenkey, fried yam, kebabs, pure water, first among others, from the canteen in ‘takeaway’ rubbers; after eating the food we put the ‘takeaway’ wrappers into the classroom waste bins.”

This view expressed by students were reiterated by the greater number of tutors interviewed. They narrated:

“During break periods, it is not uncommon seeing students coming to classrooms with food items comprising fruits, ice kenkey, cooked rice, biscuits, soft drinks, ‘wakye’, bread, pure water and fried yam etc in polythene bags; these plastic bags are disposed of into the college refuse bins.”

These results suggested that both pupils and the students consider used plastic wrappers or carrier ‘take away’ bags as landfill materials and disposed them as such. These findings were in line with a study conducted by Imam, Ncube, *et al.*, (2021) on the same subject. The authors reported that the use of plastics as food wrapper has grown to be a key aspect to successful food industries serving fast foods, ready meals, on-the-go beverages, snacks and water, among others, packaged in plastic containers. Similar study by European Commission (2018) and Lau, *et al.*, (2020) to unearth the uses of plastic also reported that the increasing on-the-go consumption of food and drinks is one of the driving forces behind the growth of single use plastic packaging globally and contributing significantly to municipal waste and the cost of hauling it away. Further study that collaborates with the findings from the present study was conducted by Onyena, *et al.*, (2021) to estimate the rate of pure water consumption for municipal planning and sustainable drinking water provision. The authors reported that the consumption of drinking water packaged in plastic sachets has soared in West Africa over the last decade and contributing significantly to municipal landfill waste.

Furthermore, the findings from the present study is also congruent with a similar study conducted in Ghana. The authors reported that pure water consumption is relatively new and fast-growing source of drinking water in West African (Stoler & Fink, 2012; Magaji, 2020). Popularly referred to as ‘pure water sachets’ have gained public affinity due to low price, convenience and public perception that sachet water is of higher quality than tap water (Stoler & Fink *et al.*, 2012; and Magaji, 2020). Another related study conducted by Nicola Wardrop *et al.*, (2017) also reported that sachet water was consumed by 63% and bottled water by 4.1% of households in Ghana this constitutes one of the reasons for the increasing plastic waste generation in Ghana.

The results of the present study further revealed that plastic waste generated in the college largely disfigure some sections of the college community and also responsible for the increasing overhead sanitation cost in the college. This was reported in one previous study that beyond the essential services that plastics materials provide to humanity (Andrady, & Neal, 2009), evidence abounds for plastics’ potential to deface important community landscapes and

quality of life (Thompson, Moore, Vom Saal, Swan (2009) (See Plate 1, 3, 7 & 8). This observation was collaborated by a study conducted by Wardrop and Dzodzomenyo *et al.*, (2017) who also revealed in their study that empty plastic sachets are notorious for constituting a major proportion of the plastic waste generated throughout the country as consumers typically litter the plastic sleeves in streets and gutters due to lack of organized solid waste collection and removal.

The increasing use and generation of plastic waste in the college is a growing concern for management as the complexity of waste management infrastructure in the college are not keeping pace with the rate of generation to deal with increasing levels of plastic waste. For example, the overflowing of waste bins with solid waste including plastic waste generated by households suggests that waste bins use by households are small and therefore inadequate to accommodate the household waste (See Plates 5). This view was reiterated by the college waste or refuse collectors. They stated:

“The college refuse bins are small and sometimes we are forced to pour the waste materials outside the refuse container when it is full to capacity; during the time of hauling the refuse away to community landfill site by contract service provider (Municipal Assembly), we had to collect the refuse or waste deposited outside into the container again-very worrying and tedious.”

Studies show that waste management has a large part to play in preventing plastic waste from defacing the environment (Ugoeze, Amogu, Oluigbo, & Nwachukwu, 2021). The authors demonstrated that incorrectly managed refuse disposal site may cause the waste to leak into the environment and disfigures the surroundings landscape (Chen, Nath, Chong, Foo, Gibbins, & Lechner, 2021) and consequently increasing the sanitation cost of hauling it to landfill sites. Another deduction from the results of the study was that some local entrepreneur considered the used plastic bottles as useful resource. For example, from a local pito brewer’s point of view, the used plastic bottles are useful resource materials. She expressed her view on this as: *“Re-using the pure water bottles saves a substantial amount of Ghana cedis that I could have used to purchase new plastic bottles for packaging the pito.”*

Perhaps, the re-use of the plastic bottles constitutes a source of revenue for her pito brewing business. A study conducted by Poulikakos, and Papadaskalopoulou, *et al.*, (2017) to determine alternative use of plastic materials considered as waste reported that plastic waste, like any other waste materials, can be useful resource. Re-using the plastic bottles also means that it never gives these plastic bottles the chance to end up in a college’s refuse dump and make them even larger than they already are. This further submits that there is the needs to stop thinking of single-used plastic as ‘waste’, but rather as a renewable resource that has alternative usage.

6. CONCLUSION

The study has provided strong evidence-based sources of plastic waste generation in the Presbyterian Women’s College of Education and their financial and environmental impacts on the college. From these findings, it can be concluded that the college’s system of plastic use pattern “on the linear model of ‘take, use and dispose’ is the primary driver of the increasing plastic waste generation in the college. This phenomenon is largely due to management failure to institute pragmatic policy measures to regulate plastic waste generation and its disposal within the college community. The consequences of this is the increasing financial and the environmental burden being imposed on the college by the increasing plastic waste generation.

7. RECOMMENDATION

The study revealed the college departments as the major source of plastic waste generation in the college. The study also discovered that the current level of plastic waste generation in the college has significant impact on both the college's financial status and the college landscape. Based on the results and discussion, the study recommends urgent administrative interventions through regulations, education and awareness creation regarding generation and use of plastic materials in the college. The college management can achieve these in three specific ways.

First, parents should be educated on the need to purchase re-usable containers for their wards. These containers can be used for long time and thus cutting down the use-and-throw-away behaviour associated with plastic waste on daily basis. This measure, however, should be linked with students' access to dishwashing kit supplies where they can wash their containers after use for re-use. Again, both parents and students should be educated on source reduction of plastic waste through re-use and recycling. Raising awareness, empowering and educating the students and staff to act collectively to minimize plastic waste generation and use alternatives options for single-use plastics must be proactively promoted and enforced.

Second, management should institute sustainable plastic waste management system by linking plastic waste reduction to the Moderator's *Academic Excellence Awards Scheme* and acknowledge the best students and staff who are much connected to plastic waste reduction in the college. The college management can also institute a second award system dubbed "*Deposit-Score-Schemes*." In this novel scheme a student who categorises plastic waste he/she generates in the college and returns them to designated post for recycling or re-use will be awarded mark that will form part of the student's final internal continuous assessment scores. Instituting both schemes will not only encourage source reduction and categorization of plastic waste, but it will also discourage single-use plastics that do not fit into any of the two award schemes.

Finally, the college management should provide adequate waste bins in the college in order to shorten the distance between houses and disposal points and at the same time encourages waste segregation at source. Instituting these measures will help reduce not only the current level of environmental and financial burden plastic waste generation continues to impose on the college, but it would also encourage the principles of circularity in plastic waste management in the college.

Study's limitation and Contribution

This study is without limitation. First, the study did not look at the organic waste component of the waste generated in the college. Second, the study also did not address the impact of plastic waste on human health in the college. Future efforts should be tailored towards these areas of research.

Nonetheless, the study brings out the existing sources and types of plastic waste generation in the college and their environmental and financial burdens on the college. The study further suggests sustainable measures management can institute to reduce the increasing plastic waste menace in the college.

Conflict of interest

The author declares that he has no competing interests.

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