

Towards Greener Printing: Examining Waste Disposal Innovations in the Ghanaian Printing Industry

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ABSTRACT

This research investigates waste disposal practices in the Ghanaian printing industry with a specific emphasis on adopting environmentally sustainable approaches. Four (4) prominent printing presses in Ghana were selected as case studies to examine their waste management strategies. The study employed a mixed-methods approach, combining quantitative statistical data on waste generation and disposal rates with qualitative insights gathered through direct interviews, observation and site visits. The finding revealed the current state of waste disposal in the selected printing presses and highlight existing challenges. Additionally, the research identifies innovative waste disposal practices that contribute to greener printing operations. Factors influencing the adoption of these innovations were explored, including regulatory compliance, economic considerations, and environmental awareness. The study highlighted the importance of transitioning towards greener printing practices to mitigate environmental impact. Recommendations are provided for stakeholders in the printing industry, regulatory bodies, and policymakers to promote sustainable waste management practices. Ghanaian printing presses specifically industrial types must understand and implement these innovations that contribute to both environmental conservation and long-term business sustainability.

Keywords: Greener printing, Ghanaian printing industry, environmental awareness, sustainability, waste disposal

INTRODUCTION

The management of waste has emerged as a significant concern for both developed and developing nations. The continuous rise in waste generation can be attributed to factors such as population growth, lifestyle choices, consumption patterns, and technological advancements. These factors have further emphasized the urgency to address this environmental issue (Debrah et al., 2021; Lissah et al., 2021). The quantity of waste produced varies across different sectors of the economy (Adedara, Taiwo & Bork, 2023). Among these sectors, the print industry stands out as a major contributor to waste generation (Hayta & Oktav, 2023). Printing is a process that involves reproducing text and images on a large scale using a master form or template. It can also be described as a traditional technique that applies a specific colouring agent under pressure onto a designated surface, resulting in the formation of text, illustrations, or the reproduction of text

and images using ink on paper through a printing press (Uddin, Hassan & Douroumis, 2022; Wikipedia contributors, 2024a).

The process of printing encompasses various techniques that enable the production of texts and illustrations in colour on any surface, creating multiple identical copies. Its significance extends to various domains such as the economy, politics, education, science, and technology, impacting the lives of individuals worldwide. Beyond reading newspapers, magazines, and books for knowledge and information, print materials have a profound influence on numerous aspects of our daily lives (B & B Press, 2024a; Wikipedia contributors, 2024b). The invention of printing from movable types by Johann Gutenberg in Mainz, Germany in approximately 1450 solidified its crucial role in the dissemination of knowledge (Lemelson-MIT, 2024; Kabir, 2024). In Ghana, the history of printing can be traced back to the early days of missionary work in the country. As early as 1851, the Methodist Mission established a printing house in Cape Coast, which was also utilized by the Basel Mission. Hutton Brew, a man from Abura Dunkwa in the Central Region, became the first African to establish a printing press in Ghana, commencing its operations in 1874. The early 1900s to the late 1930s witnessed a significant surge in printing activities within the country, driven by the growth of industrial, commercial, governmental, educational, and healthcare sectors. Since then, printing has emerged as a vital component of the publishing industry in Ghana (Eyiah, 2002).

There are various categories of printing, each with its own production process. Chea (2008) shares that throughout each stage of production, waste is generated in the form of solid waste (such as paper, mesh, and binding materials), water waste (including ink, dye, and binding agents like glue), and air emissions that pollute the printing house's air environment (Abushammala et al., 2023). Printing plays a crucial role in the global economy and significantly contributes to the advancement of education and businesses worldwide. In certain countries, it even contributes to economic growth in terms of GDP (Kotkar, 2022). Although there is no available data on the print industry's contribution to Ghana's national economy, it is widely acknowledged that the print industry in Ghana contributes to the economy and provides employment opportunities for a significant portion of the population. The impact of printing on education and the promotion of business in Ghana cannot be overstated (Chea, 2008).

The commercial printing industry is known for its heavy reliance on chemicals, resulting in the generation of various types of waste. This waste is produced during different activities such as platemaking, image processing, and printing and finishing. While some of these wastes are classified as hazardous, others may not be inherently dangerous but can still have detrimental effects on the environment if not handled properly (Chea, 2008; Australian Environment Business Network, 2003). Therefore, all types of waste generated in this industry require appropriate treatment or disposal. This holds true for printing houses regardless of their geographical location. In the context of the printing industry in Ghana, the issue of spoilage and waste control is of great significance. It has been a topic of discussion in workshops and seminars. Upon observation, it was evident that printing houses in the cities of Accra and Kumasi generate a substantial amount of waste, including papers, inks, darkroom chemicals, films, and plates. Unfortunately, this has become a common practice among the employees and management of these printing houses, without fully recognizing the negative impact that waste can have on customers, the company, the environment, and the Ghanaian society as a whole. The quantity of waste generated not only affects production costs but also poses a significant threat to the environment when it comes to its disposal (United States Environmental Protection Agency, 1990).

In Ghana, the financial burden of disposing printing waste is not imposed on printing houses. Despite the existence of regulations governing proper waste disposal, these regulations are not effectively enforced. Due to the lack of strict penalties for improper waste disposal and negligence, printing houses dispose of their waste haphazardly and indiscriminately, including in gutters, dumpsters, rivers, and on land (Odonkor & Sallar, 2021; Chea, 2008). Aydemir and Özsoy (2020) add that printing processes such as lithography,

gravure, flexography, screen printing, and letterpress employ chemicals that have the potential to contaminate sewer wastewater. The primary environmental contaminants associated with printers include silver, chromium, copper, zinc, and toxic organic chemicals. These contaminants can infiltrate and disrupt the functioning of community's water treatment plant (Rothenberg & Becker, 2002). However, the challenge lies in the absence of clear and documented data regarding the nature and volume of waste generated by printing houses in Ghana, as well as the methods employed for waste disposal (Lissah et al., 2021). To address this issue, this study aimed to investigate the waste disposal practices of major printing houses in Ghana, focusing on four specific printing houses as case studies. The study sought to evaluate the waste disposal methods adopted by these printing houses and identify the approaches utilized for disposing of waste products.

Theoretical framework

The principles of sustainable development emphasize the need for printing industries to operate in a manner that is in harmony with the environment. This study recognizes the significance of this concept and aims to explore waste disposal innovations in Ghanaian printing presses within this context. The study was guided by the three pillars of sustainability, which include economic, social, and environmental considerations (Safdie, 2023; United Nations Environment Programme (UNEP), 2009). Lipiak and Salwin (2019) support that the economic pillar of sustainability focused on the financial viability and long-term profitability of printing industries. In the context of waste disposal innovations in printing presses, this pillar highlighted the importance of finding cost-effective solutions that not only reduce waste but also contribute to the global economic growth of the industry.

The social pillar of sustainability emphasized the well-being and quality of life of individuals and communities. In the context of waste disposal in printing presses, this pillar highlighted the need to consider the social impact of these innovations on workers, local communities, and society as a whole. The study considered social considerations with the aim to identify waste disposal practices that promote social equity, health, and safety (Beattie, 2023; McGuinn et al., 2020). Also, the environmental pillar of sustainability focused on the conservation and preservation of natural resources and ecosystems (Abubakar et al., 2023). In the context of waste disposal in printing presses, this pillar emphasized the need to minimize the environmental impact of waste generation and disposal (Ferronato & Torretta, 2019). The environmental implications of waste disposal innovations were aimed to identify practices that reduce pollution, conserve resources, and promote ecological sustainability. The study incorporated relevant literature on waste management, innovation adoption, and sustainable practices within the printing industry by providing a solid theoretical foundation for the analysis of these innovations (Abubakar et al., 2023).

LITERATURE REVIEW

Global Trends in Green Printing

In recent years, there has been a growing recognition of the environmental impact of various industries on a global scale (Chu & Karr, 2017). Hayta and Demir (2023) discuss that this environmental impact has led to a heightened focus on sustainable practices in diverse sectors, including the printing industry. As a result, several research studies have been conducted to shed light on the worldwide movement towards adopting eco-friendly printing methods. These studies have highlighted the significant transition that is taking place within the printing industry, with more and more companies and individuals embracing environmentally responsible approaches (Pharr, 2023). This shift is driven by a combination of factors, including increasing consumer demand for sustainable products and services, as well as stricter regulations and guidelines imposed by governments and international organizations (Bour, Asafo & Kwarteng, 2019).

One of the key issues of these research studies is the increasing use of recycled materials in the printing

process. Many printing companies are now opting for recycled paper and other materials, reducing the demand for virgin resources and minimizing waste (B & B Press, 2024b). Additionally, there is a growing emphasis on using environmentally friendly inks and chemicals that have a lower impact on the environment. Another important trend identified in these studies is the adoption of energy-efficient printing technologies. Printing companies are investing in equipment and machinery that consume less energy and produce fewer emissions. This not only helps to reduce the carbon footprint of the industry but also results in cost savings for the companies themselves (Aydemir, Yenidoğan & Tutak, 2023).

Besides, these research studies have highlighted the importance of implementing waste management and recycling programs within the printing industry. Many companies are now actively seeking ways to reduce waste and recycle materials such as paper, ink cartridges, and packaging (Hayta & Oktav, 2023). This not only helps to minimize the environmental impact but also presents opportunities for cost savings and revenue generation through the sale of recycled materials (Australian Environment Business Network, 2003). The recognition of environmental concerns and the adoption of sustainable practices in the global printing industry have significant implications for the printing industry in Ghana. As a developing country, Ghana learns from these prevailing trends and incorporate them into its own printing practices. Ghanaian printing companies embracing eco-friendly printing methods could not only contribute to global efforts to mitigate climate change however protect the environment and also enhance their competitiveness in the international market (Williams et al., 2023). The growing recognition of environmental concerns on a global scale has resulted in a heightened focus on sustainable practices in the printing industry. Research studies have further shed light on the worldwide movement towards adopting eco-friendly printing methods, highlighting a significant transition towards environmentally responsible approaches. These prevailing trends deal with valuable insights into the overall framework within which the printing industry in Ghana operates, providing opportunities for the industry to embrace sustainable practices and contribute to global efforts towards a greener future (Pharr, 2023).

Enterprise world (2024) is of the view that printing is an essential industry that plays a significant role in various sectors, including publishing, advertising, packaging, and education. However, traditional printing methods have often been associated with negative environmental impacts, such as deforestation, pollution, and excessive energy consumption (Qing printing, 2023). Fortunately, technological advancements in the field of printing have opened up new possibilities for sustainable practices. The key area of innovation in sustainable printing is the development and incorporation of eco-friendly inks (Nestor, 2024). Tanim (2023) expresses that traditional printing inks often contain harmful chemicals and volatile organic compounds (VOCs) that contribute to air pollution and pose health risks to both workers and consumers. However, extensive research has led to the creation of eco-friendly inks that are made from renewable resources, such as vegetable oils or soybeans, and do not contain harmful chemicals or VOCs. These inks not only reduce the environmental impact of printing but also provide high-quality results (Kakoun, 2020; Arunkumar & Muthulakshmi, 2021).

In addition to eco-friendly inks, the use of recycled materials in printing has gained significant attention. Printing presses utilizing recycled paper and other materials could reduce the demand for virgin resources and minimize waste (Nestor, 2024). Recycling paper not only saves trees but also reduces water and energy consumption during the production process. Moreover, advancements in paper recycling technology have made it possible to produce high-quality recycled paper that is comparable to virgin paper in terms of printability and durability (Blanco, Miranda & Monte, 2013; Abushammala et al., 2023). Furthermore, energy-efficient printing machinery has emerged as a crucial aspect of sustainable printing practices. Traditional printing presses often consume large amounts of energy, contributing to greenhouse gas emissions and climate change. However, modern printing equipment incorporates energy-saving features, such as LED curing technology, which reduces energy consumption without compromising print quality. Additionally, the use of digital printing technologies, such as inkjet and laser printers, eliminates the need

for traditional printing plates and reduces energy and material waste (Enterprise world, 2024).

The adoption of these technological advancements in printing presses in Ghana holds great potential for minimizing their impact on the environment and embracing more environmentally conscious practices (Sec-print Ghana limited, 2023). Printing presses incorporate eco-friendly inks, recycled materials, and energy-efficient machinery could significantly reduce their carbon footprint, conserve natural resources, and contribute to a more sustainable future. Moreover, these sustainable practices enhance the reputation and competitiveness of printing businesses, as more consumers and companies are prioritizing environmentally friendly products and services. Technological advancements in the field of printing have paved the way for sustainable practices by developing and incorporating eco-friendly inks, recycled materials, and energy-efficient printing machinery (Pharr, 2023). These innovations give printing presses in Ghana the opportunity to minimize their impact on the environment, conserve natural resources, and embrace.

Environmental Impact of Traditional Printing Practices

Traditional printing techniques, such as offset printing, have long been the go-to method for producing various materials, including newspapers, magazines, and promotional materials (B & B Press, 2024a). However, recent research studies have shed light on the negative impact these techniques have on the environment. One of the most concerning aspects of traditional printing is the production of non-biodegradable waste (Aydemir & Özsoy, 2020). The use of petroleum-based inks and chemical solvents in offset printing results in the generation of large quantities of waste that cannot easily decompose. This waste often ends up in landfills, contributing to the already alarming levels of pollution and environmental degradation (United Nations Environment Programme (UNEP), 2009).

Traditional printing techniques contribute to air pollution. The release of volatile organic compounds (VOCs) during the printing process leads to the formation of ground-level ozone, a major component of smog (Tanim, 2023). This not only poses a threat to human health but also harms ecosystems and contributes to climate change. In addition to waste and air pollution, traditional printing methods also consume excessive amounts of energy. The high energy requirements of offset printing, including the operation of large printing presses and drying systems, contribute to the depletion of natural resources and the emission of greenhouse gases (Enterprise world, 2024).

Sec-print Ghana limited (2023) further shares that given these significant findings, it is crucial for Ghana and other similar regions to adopt more sustainable printing methods. One such method is digital printing, which eliminates the need for printing plates and reduces waste by allowing for on-demand printing (Chea, 2008). Digital printing also uses less energy and produces fewer VOC emissions compared to traditional techniques. Another sustainable alternative is the use of eco-friendly inks and recycled paper. Vegetable-based inks, for example, are made from renewable resources and have lower VOC emissions. Additionally, using recycled paper reduces the demand for virgin materials and minimizes deforestation (Nestor, 2024). Moreover, embracing a more sustainable approach to printing can also have economic benefits. Ghanaian printing industries adopting eco-friendly printing methods position itself as a leader in sustainable practices, attracting environmentally conscious customers and businesses. This practice leads to increased market opportunities and a positive impact on the country's economy (Qing printing, 2023).

Ferronato and Torretta (2019) continue to share that the detrimental effects of traditional printing techniques on the environment, including non-biodegradable waste, air pollution, and excessive energy usage, cannot be ignored. The urgent need for Ghana and other similar regions to transition to more sustainable printing methods is evident. Digital printing, using eco-friendly inks, and opting for recycled paper, contributes to a greener future while also reaping economic benefits (Boryor, 2023; Zappatec, 2023).

The analysis of literature pertaining to environmental policies and initiatives in Ghana provides valuable

insights into the regulatory structure that governs the operations of printing presses. This analysis involves examining various laws, regulations, and guidelines that are in place to ensure that printing presses adhere to environmentally friendly practices (Bour, Asafo & Kwarteng, 2019). The study scrutinizes the impact of current regulations on waste disposal practices, and assesses whether these regulations are effective in promoting sustainable waste management practices. One aspect that the researchers focused on was the disposal of hazardous waste generated by printing presses. Hazardous waste, such as ink, solvents, and chemicals, have detrimental effects on the environment if not properly managed (Williams et al., 2023). By studying the existing regulations and practices surrounding the disposal of hazardous waste, the researchers identified deficiencies in the current system. For example, there is a lack of clear guidelines on how to handle and dispose of hazardous waste, leading to improper disposal practices. This information was then used to recommend improvements to the regulatory framework, such as the development of stricter guidelines or the implementation of training programs for printing press operators (Lissah et al., 2021).

In addition to examining waste disposal practices, Hayta and Demir (2023) further the analysis of environmental policies and initiatives provided insights into other aspects of environmental policies and initiatives in the printing industry. For example, the researchers explored the use of sustainable materials and energy-efficient technologies in printing presses (Bour, Asafo & Kwarteng, 2019). The researchers studied successful policy implementations in different geographical areas in Ghana by identifying strategies that have been effective in promoting sustainable practices in the printing industry. These strategies included incentives for using recycled paper, tax breaks for investing in energy-efficient equipment, or partnerships with recycling companies to ensure proper waste management. The environmental policies and initiatives in Ghana provide valuable insights into the regulatory structure that governs the operations of printing presses (Abubakar et al., 2023).

METHODS

The study employed a mixed methods approach, which involved the utilization of multiple research methods (Dawadi, Shrestha & Giri, 2021). The research designs which comprised of qualitative (words) and quantitative (numbers) methods served as the overarching framework utilized to address the research question in this study (Leavy, 2022). This approach allowed for a detailed understanding of the research problem by integrating different types of data. Creswell & Creswell (2018) support that mixed methods research focuses on the collection, analysis, and integration of both quantitative and qualitative data within a single study or series of studies. The fundamental premise of this approach was that the combination of quantitative and qualitative approaches offered an understanding of research problems compared to either approach in isolation (Creswell & Creswell, 2018).

In terms of geographical location, as defined by Taherdoost (2016), it referred to the population consisting of individuals or objects that shared at least one common characteristic relevant to the study. In this study, four printing industries located in Cape Coast and Takoradi were considered. These four printing industries were situated in two regions of Ghana, namely the Central Region (Catholic Mission Press and University of Cape Coast Printing Press) and the Western Region (Saint Francis Printing Press and Takoradi Technical University Press). The selected printing houses in these regions helped the study in garnering data from a population that shared a common characteristic relevant to the study (Bowling, 2023).

The targeted population of four printing industries in Cape Coast and Takoradi metropolis were given questionnaires as part of the data collection process. The stratified sampling method was employed, whereby the staff of each printing house was divided into groups, and samples were taken from these groups (Thompson, 2012). Subsequently, the probability sampling method was utilized to select the actual sample from the groups. This method ensured that each individual in a group was chosen entirely by chance, and every member of the population had an equal chance or probability of being selected. Each individual in a

group was assigned a number, and a table of random numbers was used. The total population of the four printing industries amounted to fifty (50) individuals. Quantitative data was collected by administering questionnaires to each printing industry, while qualitative data was obtained through interviews with the Heads of the four printing industries. In total, fifty (50) questionnaires were distributed, with thirty-six (36) being allocated equally to each printing industry. Interviews were also conducted alongside the questionnaires in order to obtain additional information and ask follow-up questions (Mathers, Fox & Hunn, 2017). This process offered the advantage of gathering in-depth information and ensuring that questions were not misunderstood. The data analysis process involved describing the waste disposal strategies of selected printing industries in the Central and Western Regions. Statistical analysis and percentages were employed to analyze the data using SPSS software. The results were presented through the use of tables and accompanied by concise written explanations.

RESULTS AND DISCUSSION

Demographic Analysis

The characteristics of the participants were carefully documented and summarized in Table 1, which suggests a detailed overview of the sample population. These attributes were crucial in defining the sample for the study, but they were not included in the final results or analysis. A total of fifty individuals were initially approached to participate in the research by completing the study questionnaires. However, only thirty-six participants, accounting for 72% of the approached individuals, actively took part in the study. This discrepancy between the number of approached individuals and the number of active participants may be attributed to various factors such as time constraints, lack of interest, or other personal reasons. After the data cleaning procedure, which involved removing incomplete or inconsistent responses, thirty-six questionnaires were deemed suitable for the subsequent data analysis. This step ensured that the data used for analysis was of high quality and reliable. The final sample of thirty-six participants represents the group from which conclusions and findings were drawn in the study. It is important to note that the characteristics outlined in Table 1 were not directly utilized in the analysis, but they provide valuable background information about the participants and contribute to the overall understanding of the sample population.

Table 1: Sociodemographic Characteristics Sex of respondents

Sex of Respondents	Frequency	Percentage
Male	33	91.7
Female	3	8.3
Total	36	100.0

n = 36. Source: Field Data, 2021

Of the 36 respondents who answered the questionnaire, 33 were males thus forming the majority of 91.7%. (Table 1). This could be an indication that more males than females are employed by the printing houses.

Table 2: Age of Respondents

Age categories	Frequency	Percentage
15-19	2	5.60
20-29	15	41.70
30-39	8	22.20
40-49	5	13.90

50-59	2	5.60
60-69	4	11.10
Total	36	100.00
n = 36. Source: Field Data, 2021		

Table 3: Level of Education

Level of Education	Frequency	Percentage
JHS	2	5.60
SHS	14	38.90
O' Level	1	2.80
Tertiary	19	52.80
Total	36	100.00

n = 36. Source: Field Data, 2021

It could be seen from table 2 that majority of the workers (83.4%) of the printing houses that were involved in the study, were below 50 years. The youngest were between 15-19 years and the oldest between 60-69 years. However, the age segregation was not done for each printing house. This therefore is a broader picture covering the four printing houses. All the 36 respondents had some level of formal education from JHS to the Tertiary level. 52.8 % had Tertiary education whilst only 5.6 % had a JHS education. The level of education of the staff could make staff training easier and also, they can easily understand any new method in the printing industry leading to efficiency.

Table 4: Number of Years the Printing Houses has been in Existence

Years of the Printing Press	Frequency	Percentage
1 – 5 years	10	27.80
6 – 10 years	1	2.80
11 – 20 years	0	0.00
21 years and above	25	69.40
Total	36	100.00

n = 36. Source: Field Data, 2021

Twenty-five (25) out of the 36 respondents said their printing houses have been in existence for over 21years and 11 of them responded that their printing houses have been in existence for five years or more. (Table 4). This is an indication that the printing house used for this study have been in existence for at least 2 years or more. It is therefore expected that they would be in a position to follow best practices in their production chain.

Table 5: Number of Departments

Number of Departments	Frequency	Percentage
1 – 5	27	75.00
6 – 10	3	8.30
11 – 15	3	8.30

16 – 20	3	8.30
Total	36	100.00

n = 36. Source: Field Data, 2021

The printing houses used for the study were averagely large in terms of the number of departments. From table 5, 27 (75%) of the respondents indicated that their printing houses had about five departments whilst 9 (25%) responded that their printing houses had between 6 to 20 departments. It is therefore expected that they will be efficient in their operations. This could lead to efficiency because the various roles in the printing activity could be over seen by a department.

Table 6. Number of Employees

Number of Employee	Frequency	Percentage
5-10	10	27.80
11-15	14	38.90
16-20	1	2.80
21 and above	11	30.60
Total	36	100.00

n = 36. Source: Field Data, 2021

Some of the printing houses had employees between 5 and 10 while others had more than 21 employees. It could therefore be inferred from Table 5 that the printing houses were of varied sizes and capacities.

Table 7. Position of Respondent in the Printing House

Position	Frequency	Percentage
Print Operator	8	22.20
Bindery Operator	6	16.70
Graphic Designer	5	13.90
Polar Cutting Operator	4	11.10
Printing Technician	3	8.30
Production Manager	3	8.30
Accountant	2	5.60
Compositor	1	2.80
Estimator	1	2.80
Framer	1	2.80
Plate Burner	1	2.80
Store Keeper	1	2.80
Total	36	100.00

n = 36. Source: Field Data, 2021

The fact that only Compositor, Estimator, Framer, Plate Burner and Store keeper had one respondent each choosing them gives an indication that some of the printing houses did not have staff for the roles indicated above. Table 7. Apart from that, the other roles had staff assigned to them in all the printing houses.

Table 8. Services Provided by Printing Houses

Services	Frequency*	Percentage
Books	34	94.40
Offset Printing	34	94.40
Calendars	31	86.10
Magazine	29	80.60
Brochures	28	77.80
Posters	27	75.00
Labels	16	44.40
Banners	11	30.60
Stationery	8	22.20
Product Packaging	4	11.10

n = 36. Source: Field Data, 2021. *Multiple responses

From the above table, 8, the main services provided by the printing houses were Books, Offset Printing, Calendars, Magazines, Brochures and Posters. Between 75 to 94% of the respondents indicated that their printing house provided these services. From the responses of the respondents, Labels, Banners, Stationery and product packaging were on the low side.

Table 9. Type of Printing done at the Printing Houses

Services	Frequency*	Percentage
Offset Printing	34	94.40
Digital Printing	21	58.3
Rotogravure printing	1	2.80
Flexography	1	2.80

n = 36. Source: Field Data, 2021. *Multiple responses

It can be seen from table 9, the printing houses are engaged in Offset printing, Digital printing, Rotogravure printing and Flexography (B & B Press, 2024a). It is clear from the responses that two out of the four printing houses were involved in Rotogravure and Flexography. The findings in table 9 were not surprising. Chea (2008) has reported that Offset, Lithographic and Digital printing are the predominant printing services in Ghana.

Waste disposal practices in the Ghanaian printing industry

Waste disposal practices in the Ghanaian printing industry involve the management and handling of various types of waste generated during the printing process. This area typically produces different forms of waste, including paper trimmings, ink containers, packaging materials, and other by-products (Abushammala et al., 2023).

Table 10. Types of Waste Produced by the Printing Houses

Produce Waste	Frequency	Percentage
Yes	36	100.00
No	0	0.00
Total	36	100.00

All the 36 respondents from the four printing houses indicated that their printing houses generate waste in their production line. This confirms the assumption that there is generation of waste as part of the activities of printing houses. What is left to be answered is the type of waste generated by the printing houses. It was in order that all 36 respondents indicated that their printing houses generate waste. This is collaborated by Chea (2008), who reported that generation of waste in the printing industry cannot be eliminated and that each stage of the production line generates one type of waste or the other.

Table 11. Type of Wastes Produced by Printing Houses

Type of waste	Frequency	Percentage
Liquid waste	14	38.9
Solid waste	19	52.8
All of the above	3	8.3
Total	36	100.00

n = 36. Source: Field Data, 2021.

With respect to the type of waste produced by the printing houses as shown in Figures 1-6, 52.8% of the respondents said their printing house produces solid waste while 38.9 % said liquid waste. Only 8.3% indicated that their printing house generates both liquid and solid waste. It is however clear from the table that all the printing houses generate both solid and liquid waste since the 14 and 19 respondents for liquid and solid waste could not have come from any one of the printing houses because the respondents per printing house was 10. This is in line with Eyiah’s (2002) statement in the literature, he confirms that a good printing house generates both liquid and solid waste because the printing process makes use of solid and liquid raw materials as shown in Figures 1-6.

- Paper waste





Figure 1: Paper waste (Source: Fieldwork, 2021)

• Lithographic film waste



Figure 2: Lithographic film waste (Source: Fieldwork, 2021)

• Ink waste





Figure 3: Ink waste (Source: Fieldwork, 2021)

- **Lithographic metal plate waste**

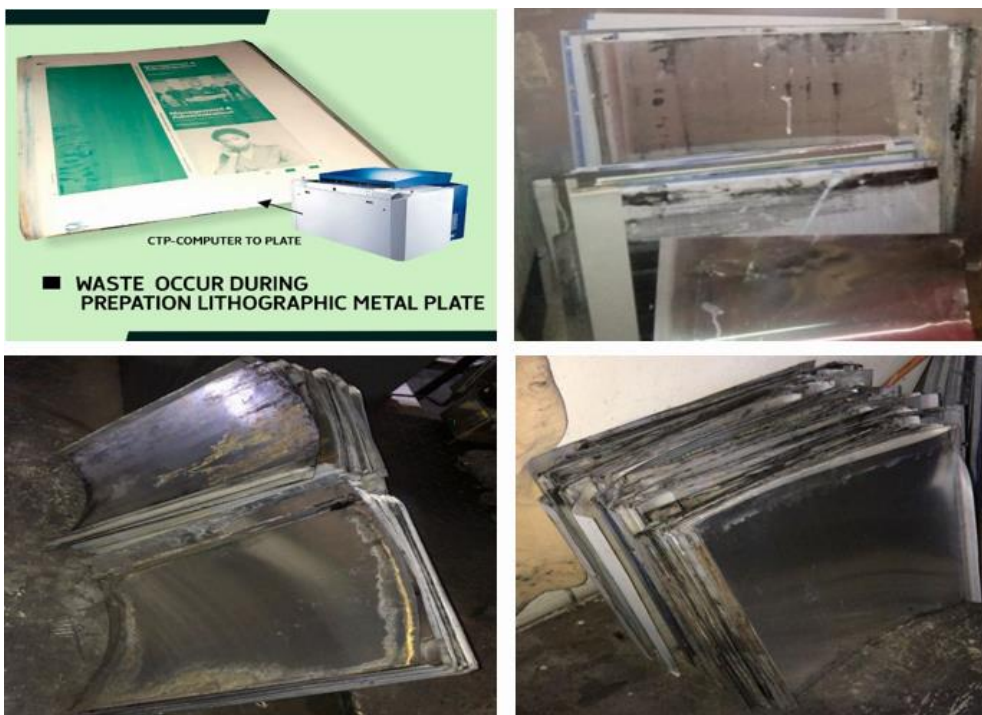


Figure 4: Lithographic metal plate waste (Source: Fieldwork, 2021)

- **Substrate waste during printing** (as indicated in Figure 5)



Figure 5: Substrate waste during printing (Source: Fieldwork, 2021)

• Other waste



Figure 6: Other waste in a printing house (Source: Fieldwork, 2021)

Table 12. Volume of Waste Produced by the Printing Houses

Volume of waste	Frequency	Percentage
Unknown	36	94.4
Total	36	100.00

n = 36. Source: Field Data, 2021.

All the four printing houses did not seem to keep records of the waste they generate from their production cycle. All 36 respondents said they had no idea of the volume of waste produced. This could be an indication that very little attention is given to the waste generated and it could affect the way the waste is handled and also the disposal methods. Table 12. According to the United States Environmental Agency (1990), tracking of waste in terms of the type produced and the volume produced is very important for any company that generates waste since it allows for proper forecasting on how to dispose of the waste even before they are produced. This is also supported by the United Nations Environment Programme (UNEP). (2009).

Table 13. Training received on Waste Disposal

Trained on Waste Disposal	Frequency	Percentage
Yes	6	16.7
No	30	83.3
Total	36	100.00

n = 36. Source: Field Data, 2021.

Most of the staff 83.3% from the four printing houses had not received any training on the appropriate ways to dispose of waste. (Table. 13). Again, this is an indication that the printing houses were probably more focused on what goes out to their clients but not how their activities impact on the environment. Training of staff on all aspects of the production line is crucial to sharpen their skills and also improve upon efficiency. Waste disposal is one of the main problem areas for printing houses, therefore regular training of staff on new methods of waste disposal is paramount to make the activities of the printing houses environmentally friendly. Odonkor and Sallar (2021), Aydemir and Özsoy (2020) and Chea (2008) have all reported variously on the importance of training on waste management to a printing industry.

Table 14. How long ago did you have this Training?

Time of Training	Frequency	Percentage
Less than 5 years	6	100.00
Total	6	100.00

n = 6. Source: Field Data, 2021.

Six of the respondents who indicated that they had gone through training on waste disposal was less than five ago. (Table 14). It could therefore be inferred that they still have some knowledge on the appropriate methods of waste disposal.

Table 15. Staff in the Printing House Responsible for Waste Disposal

Staff Responsible for Waste Disposal	Frequency	Percentage
The cleaner	11	30.60
All workers	10	27.80
Nobody is in charge	10	27.80
Junior workers/Apprentices	5	13.90
Total	36	100.00

n = 36. Source: Field Data, 2021.

From Table 15, it appears the responsibility of waste disposal is not assigned to any particular person. Cleaners or all the staff were responsible for waste management and disposal. This does not give room for effective training on waste management and could lead to waste being disposed of by those who have not received any training on waste disposal. The fact that some of the waste generated are hazardous, makes it very necessary for the role of waste disposal to be assigned to some of the staff to avoid varied ways of disposal (United States Environmental Protection Agency, 1990).

Table 16. Major Component/Material of the Waste Generated at the Printing Houses

Major components of Waste	*Frequency	Percentage
Paper	36	100.00
Ink	36	100.00
Tonner	20	55.56
Cartridge	16	44.44
Plastic	11	30.56

Metal	2	5.56
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n = 36. Source: Field Data, 2021. * = Multiple responses

From table 16, paper, ink, toner and cartridge are the type of waste that are largely produced by the printing houses, with plastic and metal being on the low side. This could be due to the type of printing that a particular printing houses engages in on a large scale. Chea (2008) had previously confirmed that there are three major waste streams found in the printing industry. They include: (a) solid waste which could consist of empty containers, used film packages, outdated materials, damaged plates, developed films, dated materials, test production, bad printing or spoilage, damaged product, and scrap papers (b) water waste from printing operations which may contain lubricating oils, waste ink, clean-up solvents, photographic chemicals, acids, alkaline, and plate coatings, as well as metals such as silver, iron, chromium, copper, and barium and (c) air emissions which are volatile organic compound emissions from the use of cleaning solvents and inks, as well as alcohol and other wetting agents used in lithographic printing. Larger plants can be the source of sulfur dioxide emissions (Nestor, 2024). Finishing operations may include final trimming, die cutting, folding, collating, binding, laminating, embossing, and assembling operations. Binding methods include stitching (stapling), gluing, and mechanical binding. The primary wastes are binding and laminating chemicals and scrap papers (Williams et al., 2023). The responses in table 16 therefore is in line with the submission of Chea (2008), Debrah et al. (2021) and Lissah et al. (2021).

Table 17. Department which Produces most Waste

Departments	Frequency	Percentage
Press	17	47.20
Post Press	14	38.90
Both	5	13.90
Total	36	100.00

n = 36. Source: Field Data, 2021.

From table 17, most of the waste generated by the printing houses come from press and post press, though almost all the departments produce their own waste. Press and post press being the departments that generate most waste as shown in table 17, is in line with the report of the Australian Environment Business Network (2003), that paper or substrate off cuts, glues, binding materials, redundant stock are some of the wastes generated from post press while old plates, plate treatment wastes evaporated hydrocarbons and oils, waste inks, cleaning solutions and paper or substrate waste are from the printing. They also reported that evaporated solvents, usually hydrocarbons and paper or substrate waste as well as old plates, residual materials generated by the flexible plate making process, cleaning solvents, waste inks evaporated solvents during the ink drying process and paper are all generated from the printing process (Bour, Asafo & Kwarteng, 2019).

18. Methods of Waste Disposal by Printing Houses

Appropriate Method of Waste Disposal	Frequency	Percentage
Yes	36	100.00
No	0	0.00
Total	36	100.00

n = 36. Source: Field Data, 2021.

All thirty-six respondents indicated that their printing presses use appropriate methods to dispose of their waste.

Table 19. Method Used for Waste Disposal

Methods Used	Frequency	Percentage
Sold for recycling	21	58.30
Burning of waste	8	22.20
Don't Know what happens to the Waste	7	19.40
Total	36	100.00

n = 36. Source: Field Data, 2021.

The methods used by the 4 printing houses to dispose of waste were; selling it out for recycling or burning of the waste. It is safe to believe that these responses had to do with solid waste. Lissah et al. (2021) reported that one of the best ways to dispose of solid waste is by recycling it into other products. According to them, a large part of press solid waste is paper and colour products. Recycled paper required less energy and water and recycled ink container can be used as new container. It was not expected for seven out of the 36 respondents to indicate that they did not know what happens to the waste since all thirty-six responded in table 18 that the appropriate methods of disposal were used by their printing houses.

Table 20. Treatment of Waste Materials before Disposal

Treatment of Waste Disposal	Frequency	Percentage
Yes	7	19.4
No	29	80.6
Total	36	100.00

n = 36. Source: Field Data, 2021.

Waste treatment is very important in the management and disposal of waste since it reduces the danger it poses to man, animal and the environment in general. From table 20, only 7 out of the 36 respondents said the waste generated by their printing house is treated before disposal while the remaining 29 (80.6%) said the waste is not treated. This may not be a good practice and does not ensure an environmentally friendly disposal method especially where hazardous waste is involved.

Williams et al. (2023) narrated that treatment of hazardous wastes is very crucial for printing houses and is principally aimed at reducing the hazardous nature of the waste in order to facilitate simpler final disposal. He reported that toxic heavy metals may be precipitated as water insoluble hydroxides, the resultant sludge being dewatered and stabilized to give a non-toxic, non-hazardous, solid material for landfill and an effluent for wastewater treatment.

Table 21. Mode of Liquid Waste Disposal

Liquid Waste Disposal	Frequency	Percentage
Poured into the drain	30	83.3

Underground Septic Tank	6	16.7
Total	36	100.0

n = 36. Source: Field Data, 2021.

On the disposal of liquid waste, 83.3% of the respondents indicated that the liquid waste is poured into drains and 16.7% indicated that the liquid waste is stored in an underground tank. This is an indication that some of the printing houses are not using the appropriate ways to dispose of liquid waste. Pouring liquid waste from printing house into drains poses a health risk to the environment since this will run into other drains and eventually find its way into other water bodies including underground water. Zappatec (2023) described that dealing with liquid waste is one of the biggest challenges of urban sanitation. It also shared that dealing with liquid waste requires capital investment, skilled personnel, coordination between different departments and that failure to manage liquid waste, leads to health and environmental problems. In some jurisdictions, failure to treat and properly dispose of liquid waste especially, hazardous waste attracts heavy fines, all to ensure that human and the environment are safe. The inability for a company to treat and properly dispose of hazardous liquid waste endangers the lives of its employees.

CONCLUSIONS

The objective of this research was to examine the waste management procedures employed by prominent printing establishments in Ghana, with a particular emphasis on four selected printing industries as case studies. The study aimed to assess the waste disposal techniques implemented by these printing houses and ascertain the strategies employed for the proper disposal of waste materials. In order to achieve efficient waste management in printing processes, it was crucial to commence with the identification and classification of the various waste types produced. This initial step facilitated a complete comprehension of the waste composition, thereby enabling the formulation of suitable waste management approaches. It was evident from the study that the waste typically generated during printing operations among these printing industries encompassed paper and cardboard waste, ink containers, residual ink, and chemicals. The implementation of effective waste collection and segregation practices was of utmost importance in printing facilities in achieving efficient waste management.

This implementation entailed the separation of various types of waste at the point of origin to facilitate appropriate recycling and disposal procedures. The categorization of waste into recyclable, non-recyclable, and hazardous groups at these printing facilities was streamlined to help the waste management process and mitigate any adverse effects on the printing environment. The study concludes that printing facilities should consider investigating possibilities for recycling paper and cardboard waste produced during the printing procedure. It is crucial for them to establish partnerships with recycling facilities to guarantee the appropriate disposal and repurposing of recyclable materials. Through the implementation of recycling initiatives, printing facilities could actively participate in the preservation of natural resources and diminish the quantity of waste that is sent to landfills. It is also crucial to handle the disposal of printing inks correctly due to their potential to cause harm to the environment. Printing facilities should prioritize recycling or safely getting rid of ink containers and any remaining ink. Pollution is avoided and the release of hazardous substances into the environment is reduced by adhering to proper ink disposal methods.

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