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Using Factor Analysis to Understand the Influence of Individual Perception on Plastic Waste Disposal

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ABSTRACT

One of the major plastic pollution problems is the understanding of the ideology underpinning their disposal. Consequently, this research aims at evaluating the factors that influence respondents' decisions on managing their plastic waste and investigate respondents' awareness of the health and safety issues associated with inappropriate plastic waste disposal. This research uses a descriptive design. 360 individuals were randomly selected in three districts within the Cape Coast Metropolis, Ghana. The data collection instrument is a structured questionnaire. The results show that the influential factors listed according to the decreasing value of factor loading are the idea that municipal authorities' inadequate collection of wastes followed by the lack of education. The next influential factor is the notion that plastics are more durable than paper next the fourth factor is the long distance the individual to a dustbin. The lack of information on the alternatives to reduce plastic waste, the increased number of people living in the area, and the high amount of plastic packaging are the fifth, sixth, and seventh strongest factors observed respectively. The lack of adequate information on proper methods to dispose of plastic waste and the attitudinal problems are the eighth and ninth dominant factors respectively. Finally, the lack of infrastructure for recycling plastic waste and the weak enforcement of existing bye-laws on sanitation are the last dominant factors observed. The factor loading values are 0.84, 0.82, 0.80, 0.72, 0.71, 0.68, 0.67, 0.66, 0.64, 0.61, and 0.58 respectively.

INTRODUCTION

Plastics have become one of the most harmful contaminants due to their rising use. Inadequate knowledge of controlling plastic waste almost always results in environmental pollution and associated health problems (Borrelle et al., 2020). Since plastics are inexpensive and readily available, it has a wide range of applications in the food sector (Alimba et al., 2019). Plastic materials contain certain hazardous compounds which pollute the air, water, and soil (Alimba et al., 2019). It also results in the extinction of important species, a reduction in water quality, and a decline in marine organisms, creating problems in navigation, and marring the beauty of the environment (UNEP, 2016). Besides, Leggett et al. (2014); Drimili et al., 2020 argue that a considerable amount of plastic waste originating from the land flows into the seas, endangering coastal organisms and millions of people who rely on fishing activities for a living. In addition, Walker (2018) asserts that plastic debris might be present in every marine habitat, making marine pollution a worldwide issue. Although, for that reason, Zen et al. (2013); Cai et al. (2020) claim that public attitudes toward plastics have shifted from positive to negative in Western developed civilizations, this shift has yet to occur in developing nations, particularly in Africa. Likewise, Stoler et al. (2012); Zand et al. (2020) posit that due to the general population's significant reliance on plastic products, public opinion in industrialized nations is still supportive or, at best, ambivalent. Plastic materials have been the most prevalent carrier products,

frequently given away freely. Also, Adam et *al.* (2020); Islam et al., 2020 affirm that plastic products are used to carry potable water, which most people consume due to the lack of access to clean water. The most prevalent and least-priced packing material is plastic. As a result, Stoleret al. (2012) and Kim et al. (2020) deduce that plastic items are deeply ingrained in most people's everyday lives in developing nations, and a positive or neutral view of plastics is commonly recognized.

Heidbrederet al. (2019) view that the widespread use of plastic materials has led to increased plastic litter. This soaring rate of plastic waste has a set of economic, ecological, and societal repercussions. Heibrederet al. (2019) add that plastics are resilient and persistent exacerbates the environmental concerns associated with plastic waste disposal. Plastics clog sewers, endanger animal life, degrade soil, and pollute coastlines when they are not safely disposed of. Furthermore, attitudes are frequently employed to describe most of these environmental issues since they have been discovered to impact specific perceptual standards translated into social behaviors (Dilkes-Hoffman et al., 2019). Zwicker et al., 2019 argue that individuals and community attitudes and awareness regarding pollution and waste disposal are crucial to meet the management issue.

Polyethene waste comprises wrappers, plastic bottles, water sachets, polythene bags, and other plastic products. These different types of plastics derivate products account for the bulk of post-consumer waste created in Ghana (Miezah et al., 2016). The increasing volume and pace of creating solid garbage in the Cape Coast Metropolis, Ghana, are causing concern. In the Central Region of Ghana, open dumps are the most typical form of solid waste disposal (Adam et al., 2021). A variety of reasons may contribute to the ineffective handling of plastic waste. Various community sectors will find multiple tactics beneficial for plastic waste treatment and disposal, making the obstacle to solid waste management in Cape Coast highly distinct regarding environmental implications, socio-economic issues, and cultural legacy. Since local dwellers are the principal final users of waste disposal facilities, it is critical to stress their role, perspectives, waste disposal habits, and relationships with other players in collecting and disposing of the waste (Negussie et al., 2017).

Many studies have suggested that the strategy is related to waste management with either at-home safety awareness (Ojewale, 2014) or knowledge of waste-related adverse health outcomes. Following this, Grimmer and Woolley (2014) regarded attitude as a precursor to behavior, so understanding the attitude that underpins behavioral patterns is necessary to modify it. Therefore, public perception and understanding are two of the most important and urgent parts of the problem that must be tackled to increase public support for future administration programs and activities. As a result, this paper fills a critical knowledge gap by scientifically investigating the influence of individual perception on plastic waste management attitudes to grasp the mental ideology better underpinning their consumption of plastic materials. Hence, this research at three selected districts in the Cape Coast Metropolitan, Ghana, evaluates the factors influencing respondents' decisions on managing their plastic waste and investigates respondents' awareness of the health and safety issues associated with inappropriate plastic waste disposal.

MATERIALS AND METHODS

Study Area

The research took place at the Cape Coast Metropolis, Ghana. Three districts, namely Kotokraba, Efutu, and Abura, are within the Cape Coast Metropolis. These districts have been selected because of their huge waste generation. Besides, few studies have been performed using these districts.

Research design

Since the study aimed to assess the population of Cape Coast's (Ghana) perceptions of plastic waste disposal, a descriptive approach was selected. In addition, the research also employed a cross-sectional design since the study aims to evaluate the underlying factors affecting people's perception of plastic waste management among Cape Coast inhabitants. Therefore, the Cape Coast Metropolitan, Ghana, residents were included in the study.

Sample Size and Sample Technique

The study was conducted in three communities: Kotokraba, Abura, and Efutu in Ghana. The overall population of the Cape Coast Metropolis was 189,925 in 2021 (Ghana Statistical Service, 2021). Using Ahmad and Halim's (2017)

sample size calculation, a sample of 384 people was taken from 189,925 people. The sampling technique used in the study was random. The initial number was produced at random using the Q-Basic software application. Then the target population was divided by the sample size needed to find the sample proportion. After that calculation, the result found was 494. This was the sampling interval used to sample all 384 respondents. The research used a sample of 360 individuals due to difficulties related to time, economic constraints, and other operational challenges. A small sample size is not required for a homogeneous population (Sarantakos, 2012). As a result, the 360 respondents for the study proved to be suitable. Therefore, the 360 respondents for the study proved to be appropriate.

Data Collection

The data collection instrument used for the three selected communities (Kotokraba, Abura, and Efutu) within the Cape Coast Metropolis, Ghana was structured questionnaires. The questionnaire was divided into three sections. The participants' demographic information was sought in Section A. Section B collected data on the factors that influence respondents' decisions about managing their plastic waste. Section C gathered information on respondents' understanding of improper plastic waste disposal's health and safety risks. The questionnaires were pre-tested. From the 360 questionnaires administered to participants, only 351 were collected from the three districts. The respondents who filled out the questionnaires were 119, 114, and 118 from Kotokraba, Abura, and Efutu, respectively.

Data Analysis

The statistical program for the social sciences (SPSS) version 26 and Stata version 17 analyzed the data. The respondents' demographic characteristics in this study were described using descriptive statistics. Descriptive statistics were used to assess the respondents' comprehension of the health and safety issues connected with the inappropriate disposal of plastic waste. Furthermore, factor analysis was utilized in the study to determine the most influential dominating ideas about plastic waste and its disposal that are most capable of affecting people's attitudes about waste disposal. These beliefs impacted respondents' opinions and behaviors regarding waste disposal in the chosen communities. Finally, Principal Component Analysis analyzed 11 items related to respondents' perceptions of indiscriminate plastic trash disposal (PCA) environmental consequences. It was employed since it preserves patterns and trends while reducing a large data collection dimensionality (Liwicki et al., 2013). Moreover, the value found for the Kaiser-Meyer-Olkin (KMO) sampling adequacy was 0.814, proving our factor analysis's validity.

RESULTS AND DISCUSSION

Demographic Information

Table 1. Demographic Data

	Demographic	Frequency	Percentage (%)
Gender	Male	154	41.3
	Female	197	52.8
Age	20-30	89	26.1
	31-41	159	42.6
	42-52	57	15.3
	Above 52	44	11.8
Type of Occupation	Self-employed	182	48.8
	Government Employed	89	23.9
	Unemployed	80	21.7

Income Level	100-500 GHC	132	49.3
	501-1000 GHC	114	30.6
	1001-1500 GHC	18	4.8
	Above 1500 GHC	35	9.4
Level of Education	Primary	59	15.8
	JHS/Middle form 4	101	27.1
	SHS/ 'O' Level	61	16.4
	Tertiary	118	31.6
	None	12	32
Marital Status	Married	181	48.5
	Single	137	36.7
	Divorced	15	4.0
	Widowed	18	4.8
	Kotokraba	119	31.9
Locations	Abura	114	30.6
	Efutu	118	31.6

Descriptive Statistics (N=351)

Table 1 presents the demographic data of individuals. It can be seen from the demographic data that men made up 41.3%, while females made up 52.8% of the population of the respondents. In addition, most respondents were 26.1% and 42.6% between 20-30 and 31-41, respectively. Also, respondents between 42-52 and above 52 years of age have 15.3% and 11.8%, respectively. This showed that the majority of the respondents were mature. Moreover, it is shown that 48.8% of the respondents are self-employed, 23.9% are government-employed, and 21.7% are unemployed. Furthermore, looking at the respondents' income levels, the survey found that 49.3%, 30.6%, 4.8%, and 9.4% of the respondents have a monthly income in Ghana Cedis ranging between 100-500, 501-1000, 1001-1500 and above 1500. Additionally, on the education level, 15.8%, 27.1%, and 16.4 % of the respondents have the level of primary school, JHS/Middle form 4 level, SHS/'O', and tertiary education, respectively. However, 32% of the respondents were illiterate. Simultaneously, the table reveals that 48.5%, 36.7%, 4%, and 4.8% of the respondents were married, single, divorced, and widowed.

Factors influencing the perceptions of individuals on plastic waste disposal

Table 2. KMO and Bartlett's test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.814
Bartlett's Test of Sphericity	Approx. Chi-Square	1662.127
	Df	66
	Sig.	.000

The occurrence of numerous coefficients of 0.1 and higher was observed in the correlation analysis. The determinants were shown to be 0.008. This indicated that the dataset did not contradict the correlation intensity requirement. Table 2 presents the Kaiser-Meyer-Olkin (KMO) test results. The value found for the Kaiser-Meyer-Olkin sampling adequacy was 0.814, which was higher than the suggested value of 0.6 (Glen, 2016). In addition, Bartlett's Test of Sphericity was significant with a (p-value< 0.05), indicating an excellent linear relationship within the variables (Table 2).

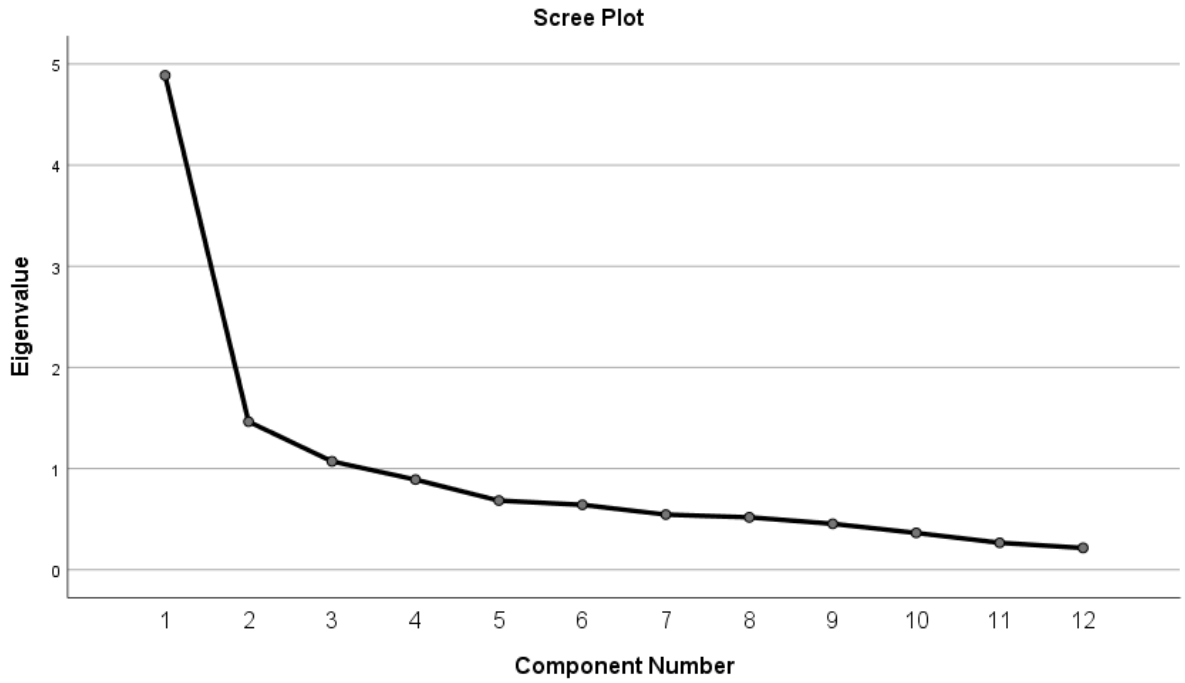

Figure 1. Scree Plot

The principal component analysis revealed that the three components with Eigenvalues were more significant than those explained at 40.73%, 12.20%, and 8.93% of the matrix. Figure 1 shows the trend of the components (Scree Plot). A closer look at the scree plot reveals a distinct discontinuity following the third component (Figure 1). Therefore, three components were chosen for this work by applying the scree test of Cattell.

Maintaining factors with an eigenvalue more significant than one is built on the hypothesis that a component is of negligible importance if it describes more minor variations than a single variable (Bandalos and Finney, 2018). The parallel analysis confirmed the selection, with just three components having eigenvalues superior to the equivalent thresholds for an utterly random matrix of a similar size (11 variables x 351 respondents).

Table 3. Variance and EigenValues

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% Of variance	Cumulative %	Total	% Of variance	Cumulative %
1	4.887	40.728	40.728	4.887	40.728	40.728	3.293	27.444	27.444
2	1.464	12.199	52.927	1.464	12.199	52.927	2.368	19.734	47.178
3	1.071	8.927	61.854	1.071	8.927	61.854	1.761	14.676	61.854
4	.891	7.423	69.277						
5	.683	5.695	74.971						
6	.641	5.346	80.317						
7	.545	4.543	84.860						
8	.518	4.315	89.175						
9	.454	3.782	92.957						
10	.364	3.031	95.989						
11	.266	2.215	98.204						
12	.216	1.796	100.000						

Extraction Method: Principal Component Analysis.

Table 3 presents the variance and eigenvalues. From the table, it is revealed that the three main components explain 61.85 percent of the matrix. This confirms Sauerbrei's (2020) assertion, which stipulates that it is commonly assumed that the collection of variables or components chosen should describe a minimum of 40% of the variation.

Table 4. Rotated Component Matrix

Rotated Component Matrix			
	Component		
	1	2	3
Attitude problems due to lack of care in the proper disposal of plastic waste			.644
lack of education			.825
Weak enforcement of existing bye-laws on sanitation			.577
Inadequate collection and disposal of waste by municipal authorities		.844	
Lack of adequate information on proper methods to dispose of plastic waste		.646	
Increased number of people living in the area	.680		
Long distances of the individual to a dustbin	.721		
Lack of information on the adverse effect of improper disposal of plastic waste on the environment and human health			
Lack of information on the alternatives to reduce plastic waste	.707		
Lack of infrastructure for recycling the plastic waste		.606	
Plastics are more durable than paper	.802		
A high amount of plastic packaging	.666		

According to Samuels (2017), all factor loadings higher than 0.3 are considered good values. Table 4 presents the rotated component matrix. The findings show that all the factors that influence the individual perception of plastic waste disposal have factor loadings above 0.3. The factor loadings show the magnitude of influence that each factor has on the attitude of respondents towards plastic waste disposal. The results show that the most influential factor in individual perception of plastic waste disposal was the idea of municipal authorities' inadequate collection and disposal of waste, with a factor loading of 0.84. This means that the respondents believe how plastic materials are collected and disposed of in the selected communities might affect plastic waste management. Several landfills full of plastic materials can be identified in the chosen communities. The sight greatly influenced how people perceive the importance of disposing of plastic materials. This result was justified by Cheng (2019) and Almasi et al. (2019), telling us that attitudes, behaviors, and thoughts acknowledged and reinforced are more probable and eventually integrated into our own belief set and regular habit.

The second most dominant factor is the lack of education (factor loading = 0.82). This emphasizes that respondents found it extremely important that the lack of education plays a significant role in how plastic materials are disposed of in the selected communities. This was justified by Filho et al. (2018); Coskun et al. (2020), who supported the notion that education may shape people's environmental views. The third most dominating factor impacting respondents' perceptions of waste disposal was the notion that plastics are more durable than paper, with a factor loading of 0.80. During the data collection process, many respondents stated that plastics are more durable and could be used several times compared to other materials.

According to the study, the long distance of the individual to a dustbin is the fourth most important factor selected by the respondents, with a factor loading of 0.72. In fact, there was no dustbin around in many of the locations where the data were collected. Sometimes, the few presents were far away from the main buildings. So, people end up throwing garbage in the street. Garbage bins have been highlighted several times in studies as a

priority for waste disposal. Thus, when these are not accessible or available in a particular place, this is the cause of enough littering (Watts et al., 2017; Khanam et al., 2019; Dilkes-Hoffman et al., 2019).

The three most influential factors have been described in the factors analysis consideration. The fifth most influential factor was the lack of information on the alternatives to reduce plastic waste (factor loading = 0.71). From the result of the awareness conducted in our study, people were aware of the danger that improper disposal of plastic materials can cause. However, when questioned why they still do that, most answered they had no other alternatives. This was emphasized by Cammas-Marion et al. (2021) and Cheang et al, 2019 in their studies in which it is demonstrated that the presence of alternative methods has an impact on the disposal of plastic waste.

The other factors such as the increased number of people living in the area, the high amount of plastic packaging, the lack of adequate information on proper methods to dispose of plastic waste, the attitudinal problems due to lack of care and inappropriate disposal of plastic waste, the lack of infrastructure for recycling the plastic waste and the weak enforcement of existing bye-laws on sanitation have a factor loading 0.68, 0.67, 0.66, 0.64, 0.61, 0.58 respectively.

According to the Ghana Statistical Service (2022), the Ghana population is rapidly increasing. As of 2012, the Ghana Population was around 19 million. Today, it has reached 32 million. This sharp increase, coupled with the lack of infrastructure for recycling, and the weak enforcement of bye-laws, have a considerable impact on how people dispose of their plastic waste. In addition, the fact that the population is increasing would also raise the use of plastic materials. Knowing there are no strict regulations on plastic materials in Ghana, one individual may use more plastics than required in a day (Bhattacharya et al., 2018; Jambeck et al., 2018; Rhodes, 2018).

Attitude is also found to be an essential factor in waste management. Reynolds (2015); Kurtela et al., (2019) argued that opinion change is a sort of action wherein the agent of change exerts a societal impact. They stress that the extent of the effect is determined by the priority the subject places on changing one's mind to achieve one's objective, preparedness. This implies that dumping plastic products in the environment might be due to a mindset challenge or that not everyone views plastic waste the same way. According to Moore (2012); Lestari et al. (2019); Chen (2022), waste can imply different things to different individuals. For example, some individuals, such as Ghana's garbage pickers, perceive waste as a resource or a method to supplement their income in an otherwise scarce labor market. Simplicity, cultural norms, a lack of public participation, and a lack of awareness and education about proper waste disposal measures are all variables that lead to this behavioral attitudinal disparity (Udawatta et al., 2018; Chae et al., 2018). Overall, it is observed that all the factors stated had influenced the individual perceptions of respondents on plastic waste management.

Table 5. Individual opinions on whether improper management of plastic waste cause diseases

	Frequency	Percent
Yes, it causes diseases	210	98.1
No, it does not cause diseases	1	0.5
Do not know if it causes diseases	2	0.9
Total	213	99.5

Table 6. Individuals' knowledge of the different types of diseases caused by improper plastic waste disposal

	Frequency	Percent
Malaria	188	87.9
Diarrhea	9	4.2
Others	12	5.6
The three diseases	4	1.9
Total	213	99.5

Individual's knowledge of the health and safety risks posed by improper disposal of plastic waste

It is observed that individuals were well aware that disposing of plastic waste in a harmful manner is a problem for human health and the environment. Table 5 presents the individual opinions on whether improper management of plastic waste cause diseases. Almost 98% of the respondents agreed that it causes diseases, and the primary condition known by respondents is malaria. Table 6 presents the individuals' knowledge of the diseases caused by improper plastic waste disposal. The respondents mentioned other diseases, such as cholera and diarrhea. The accumulation of plastic debris, particularly plastic bags and other disposable items, can promote the spread of vector-borne illnesses, including malaria, by blocking sewers and producing breeding grounds for vermin and mosquitoes (Bebbington et al., 2018). Furthermore, World Health Organization (2014) report shows that numerous chemical additions that give plastic goods favorable functional properties harm human health and the ecosystem. The leaching of harmful chemical elements into food, beverages, and water, as well as reproductive problems, which could also result in cancers, birth anomalies, inflammatory diseases, and developmental difficulties in toddlers, have been some of the direct adverse effects of plastic products (Ilyas et al., 2018; Alabi et al., 2019; Resma et al., 2020; Chang et al., 2020).

CONCLUSION

The factors influencing plastic waste disposal are keys to providing a solution for plastic waste management. This study provides data on determinants that may help improve plastic waste management. The paper evaluates the factors inducing respondents' decisions on managing their plastic waste and examines respondents' awareness of the health and safety issues associated with inappropriate plastic waste disposal. Policymakers may use this study's findings to improve Ghana's sanitary conditions. The use of factor analysis for this study was adequate since the KMO value was 0.814, and Bartlett's Test of Sphericity was significant with a (p-value< 0.05), indicating an excellent linear relationship within the variables. Eleven factors are identified to be influential according to respondents' perspectives. The idea that municipal authorities' inadequate collection and disposal of wastes is the first factor identified. It is followed by the lack of education, the notion that plastics are more durable than paper, and the long distances of the individual to a dustbin.

The lack of information on the alternatives to reduce plastic waste, the increased number of people living in the area, the high amount of plastic packaging, and the lack of adequate information on proper methods to dispose of plastic waste are also some factors identified to cause indiscriminate waste disposal. Finally, the attitudinal problems due to lack of care and inappropriate disposal of plastic waste, the lack of infrastructure for recycling plastic waste, and the weak enforcement of existing bye-laws on sanitation are also found to influence plastic waste disposal. Furthermore, this study has the potential for further development. For instance, other factors include how individuals perceive waste, the willingness to recycle their waste, and the willingness of individuals to abide by the laws if alternatives are provided. Besides, the weight of plastic waste generated per individual could be measured to identify specific factors underpinning the difference observed among individuals.

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