A STUDY OF PROBLEMS ASSOCIATED WITH PET BOTTLES GENERATION AND DISPOSAL IN KANO METROPOLIS

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ABSTRACT

The purpose of this study was to assess the problems associated with PET bottles generation especially with respect to the pattern of consumption of drinks packaged in PET bottles, management (disposal) of waste PET bottle and socio-economic and environmental implications. The study adopted descriptive survey design, and data were collected using questionnaire administered to 150 respondents randomly selected from twelve wards in six out of the eight metropolitan local government areas in Kano state. The sample were selected and logical inferences (deductions) and/or generalizations were made from the results of data analysis based on a statistical probability of 8 percent sampling error at 95% confidence level. The results shows that PET bottle waste generation was high in the metropolis and that the observed situations was due more to consumerism (uncontrolled or unguided acquisition tendency) as consumers are generally aware of the implications but still kept on consuming the product which continue to add more to the solid waste stream. It was also found that disposal of PET bottles was accosting the urban Kano residents and environment so much in many ways. a comprehensive and objective review of government policies and programmes on environmental, economic and industrial development and public-private partnership in areas of research, information sharing and public reorientation that will focus attention on reverting the current trend are suggested as possible panacea to the problems identified.

Keywords: PET Bottles, Generation, Solid Waste, Waste Management, Kano Metropolis.

BACKGROUND OF THE STUDY

The use of Polyethylene terephthalate also known as PET or PETE (a plastic resin materials used for making packaging materials such as bottles and food containers) is increasingly becoming paramount among manufacturers, as they used these PET bottles to package their products because it (PET) is an excellent barrier material with high strength, thermo stability and transparency. Consumer also prefer or choose PET because it is inexpensive, lightweight, reseal able, shatter resistant and recyclable among other reasons (NAPCOR, 2011). Every year not less than 200 billion bottles of bottled water are consumed globally. Only about 15% of this quantity is recycled in all recycling plants across the globe while the remaining ones end up in trash bins, landfills or open dumpsites in cities across the globe (Wikipedia, 2011). The consumption of carbonated drinks, beverages and food items packaged in PET bottles is also on the increase producing the same effect as that of bottled water (EPI, 2011).

Generally, the increase in the consumption of PET bottle products has been linked to consumerism or consumer culture. Studies have shown that people associate consumption of bottled water with healthy living, and that the attraction created by the product design and some other intrinsic and extrinsic factors tend to create a bond of connection between the products and the consumers (WWI, 2010). This bond of connection manifests in the increasing rate of PET bottle products in places across the globe. The rate of plastic waste generation is also increasing as a result.

In Nigeria, PET bottle products (especially bottled water) have been in the market for quite some years but more of the products are gaining popularity and attention in recent years (EPI, 2011). In recent years various carbonated drinks producing industries in the country have launched and introduced various kinds of PET bottle packages of their brands into the market. According to a survey by Euro Monitor International (EMI, 2009), these PET bottle packages are performing quite well in the

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competition with other types of packaging materials in the market. Oni (2011), opined that, not less than 200 million PET bottles are produced in Nigeria per day. This is quite a huge amount. The problem here is that consumption of the products only creates waste which is beyond the capacity of the producers to manage.

In Kano, all of the various brands of bottled water, soft drinks, beverages, fruit juice and milk drinks are available in the market in different types of packaging materials-PET bottles, cans, glass bottles, polythene sachet and synthetic paper packages. On the basis of basic economic theory of market competition, each packaging material tends to compete with the others for attraction and consumption by consumers. PET bottle package of most of the brands of different types of drinks is relatively new in the competition but has equal and good chance of attracting consumers like the other packages. It is therefore worthy of study to find out how this new products are being consumed by consumers and how the resultant waste bottles are being collected and disposed of. The aim of this research work is to assess problems associated with PET bottle generation and disposal in Kano metropolis.

Four hypotheses were raised based on the inherent nature of the data generated from the survey. The analysis of these hypotheses provided answers to the questions and also helped in ascertaining the earlier observations and analysis empirically. The questions raised were as follows:

i. Is there any spatial variation in consumers preference for drinks packaged in PET bottle in different parts of Kano metropolis?
ii. Are consumers of PET bottles products aware of the implications of consumption of such product on the environment?
iii. Is there any relationship between consumer awareness and consumption of the product?
iv. Is there any relationship between consumer's income status and consumption of PET bottle products?

CONCEPT OF PET BOTTLES AND SOLID WASTE MANAGEMENT

Solid waste has been described as any discarded material that is not a liquid or gas (Karen, 1996). The United States Congress in the 1976 Resource Conservation and Recovery Act defines solid waste as "Any garbage, refuse, sludge from a waste treatment plant or air pollution control facility and other discarded material including solid, liquid, semi-solid or contained gaseous material resulting from industrial, commercial, mining and agricultural operation and community activities" (Meenakshi, 2010). A solid waste can be plastic, metal, paper, vegetable, rubber, wooden, glass or polythene material (Omolade, 2002)

Environmental management system refers to a coordinated system or techniques of managing the environment to make sure that it is stable, sustainable, and maintains its quality (Randolph, 2004; Olofin, 2010). One of the components of environmental management system is waste management. This involves planning, regulating, control, collection, transportation, evacuation, storage, treatment and monitoring of waste and waste generation processes as well as coordinating all management strategies in such a way as to maintain the quality, stability and sustainability of the environment (Chatterjee, 2006; Ikelegbe, 2008).

Integrated waste management is a contemporary concept of waste management which according to Botkin & Keller (1998) is best defined as a set of management alternatives including reuse, source reduction, recycling, composting, landfilling and incineration.

Reuse

This involves putting the material that potentially constitute a waste into new kind of use i.e using a material which has been used already for new purposes in order to reduce waste accumulation. For example, using a used container or packaging container to package new product (Karen, 1996; Botkin and Keller, 1998).

Source Reduction

This involves reducing the rate of consumption of particular product either by reducing the volume of production, quantity consumed or by reusing or recycling certain materials as raw materials in the production process so as to minimize the quantity of waste output emanating from consumption of such products (Karen, 1996; Botkin and Keller, 1998; Meenashi, 2010).

Recycling

This involves using waste materials as raw materials for producing a variety of products which are useful and marketable (Karen, 1996, Green *et al.*, 1998). For example, PET bottles are recyclable and are recycled to produce different products such as film and sheet, plastic strapping, food containers, plastic bottles etc. Recycling helps the environment in many ways. It saves landfill space, energy and natural resources. It also reduces the damage caused by mining, cutting trees, and manufacturing (Karen, 1996). It has been noted that recycling has the capacity to reduce the total volume of trash an average person is likely to generate in a lifetime by 60 percent (Feather, *et al.,* 1993). Recycling also reduces (or has the capacity to reduce) the municipal waste by 30% (Botkin & Keller, 1998).

In countries like Japan and Germany 50% of the garbage is recycled because recycling is mandatory. In some other advanced countries of the world less than 30% of the total municipal waste is recycled annually while countries in the South (i.e. developing countries) are also adopting recycling as a method of managing their municipal waste (Feather *et al.*, 1993; Stout, Green *et al.*, 1997; Botkin & Keller, 1998). Generally, recycling as a waste management strategy is advantageous and effective but expensive.

The idea of packaging drinks with PET bottles was embraced by manufacturers and consumers in the 1940s after when some scientific experiments had proven that bottling drinks with PET bottles was not harmful to human health contrary to the initial fear that PET was not suitable for packaging drinking products. The product soon became popular and widely used in most parts of America (US) and Europe and from there it spread fast to other parts of the world (Wikipedia, 2011). Advanced countries of the world generate more PET bottle waste and other kinds of plastic waste due to their high per capital consumption of drinks of different kinds packaged in PET bottles and other related or similar packaging materials (WWW, 2011).

PET bottles are frequently used for plastic carbonated beverage and water bottles (NAPCOR, 2011). PET plastic bottles have clear and optically smooth surfaces for oriented films and bottles. They are excellent barriers to oxygen, water and carbon dioxide and possess high impact capability and shatter resistance. PET bottles also have excellent resistance to most solvents and good capability for hot-filling (Wikipedia, 2011). Customers choose PET bottles because it is inexpensive, lightweight, reseal able, shatter resistant and recyclable (PCI, 2011). Many products can be produced from PET bottle recycling including plastic film and sheet, plastic strapping, food containers, comfort fill, tote bags, fleece jacket, water bottles and carpet fibres (WWI, 2011).

It has been noted that the global rate of consumption of PET bottle more than quadrupled between 1990 and 2005 (Wikipedia, 2011). By one estimate, approximately 50 billion bottles of water are consumed per annum in the United State of America and around 200 billion bottles are consumed globally (WWW, 2011). In 2009, approximately 5.8 million tons of PET was collected globally for recycling while greater amount end up in landfills and open dumps in countries around the world (EPI, 2011). In the US less than 24% of the total PET waste generated is recycled annually while the remaining ads to the enormous volume of household and municipal waste generated in the country (LAT, 2011). Globally, 86% of all disposable water bottle become garbage and litters (NYT, 2011). In Canada it was estimated that 30% of Canadian household consume bottled water in 2006 (CBC, 2011). This implies that several millions of PET bottles were used up in the process as water is usually bottled in PET bottles. Large percentage of the waste bottles end up in landfills since only less than 30% are recycled annually in the country (Canada) (WWI, 2011).

Oni (2011) reports that the most prevalent form of packaging liquid product (bottle water and beverages) in Nigeria and all over the world now is in PET bottles. The demand for PET bottle according to the report is very high as its production is in the range of 200 million per day in Nigeria.

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Coca-Cola bottling company reports that 100 metric tons of PET bottle (approximately 15 million PET bottles) were recycled monthly in its recycling plant in 2005 and that $ 500,000 was expended on PET bottle recycling in Nigeria in the year (EMI, 2011). By implication only a small percentage are recycled and therefore a greater quantity of the waste bottles end up as garbage or litter in the streets and disposal points in locations across the country. The reports of other carbonated drinks and table water packaging industries in the country reveal that Nigerians are found of consuming drinks packaged in PET bottle at quite high rate. This has a lot of implications for environmental and waste management. Some of these implications are discussed in details in the next unit.

Generally, bottled drinks are consumed at very high rates in countries around the world. Research have shown that bottled water manufacturing is the world's fastest growing industry and that PET bottles are now more preferred by water and carbonated drinks industries around the world. Studies by World Watch Institute (2011) have also shown that people associate bottled water with healthy living. All these put together are responsible for the uncontrolled rate of production and consumption of PET bottles which in effect is contributing to increase in garbage volume in countries across the world. It has been estimated that 2.7 million tons of plastic are used to bottle water products every year but less than 15% of the gross waste output of this quantity is recycled globally (EMI, 2011).

Environment responds to virtually all manipulative and destructive activities of man on the earth surface including solid waste disposal (Olofin, 2010). Solid waste as noted by Omolade (2002) is one of the most acute types of environmental degradation that has engulfed and blighted our cities in recent years. Indiscriminate solid waste disposal and accumulation at different spot contribute to land degradation and pollution (Ogunnowo, 2000).

Insects and/or vectors that transmit different kinds of diseases thrive and procreate in refuse dumpsites and hence the sites contribute to spread of different kinds of disease (Meenakshi, 2010). Indiscriminate disposal of garbage often leads to formation of heaps of refuse and litters in the streets and in most cases causes the environment to lose its beauty and aesthetic value thereby creating ugly sites in the environment (Ikelegbe, 2008).

Refuse dumpsites are also known for releasing bad odour the effect of which can be nauseating, irritating or repulsive making life uncomfortable for dwellers and passers-by within the vicinity (Botkin & Keller 1998; Ogunmowo, 2000).

Refuse disposal sites also competes with other types of landuse especially agricultural and residential land uses. Open refuse dumps often cover a good amount of land space in towns and cities. For example, the Fresh Kills in New York (the largest waste disposal site in the world occupy about 1500-ha (3700 acres) on Station Island (Botkin & Keller, 1998). Craig *et al.,* (1988) noted that land which had been used at one time or the other as landfill is not suitable for building. Shortage of land for housing development can therefore result in areas where a good deal of land space has been used for landfill or as dumpsites.

Leachate is another environmental problem associated with solid waste disposal in landfills in some urban centres. Leachate refers to the gradual process of mineralization due to material-water reaction, biochemical decomposition of refuse materials and subsequent percolation of the mineralized (water) chemical substance from the landfill through the vardose of the soil down to the water table (Deju *et al.,* 1990; Karen, 1996; Botkin & Keller, 1998). This often led to the contamination of the underground water. Leachate could cause very serious health problems especially in places where water is not treated before consumption (Radolph, 2004).

It has also been noted that both microbial and chemical activities going on in refuse dumpsites produce and release high amount of carbon dioxide which also contribute to the greenhouse effect (global warming) and consequently climate change (Bradshaw, 2007). The processes associated with commodities production, waste generation, waste management including clearing of land for landfills and open dumps, sitting of recycling plants, industrial recycling activities, incineration and others con tribute directly or indirectly to climate change phenomenon. Incineration of used bottles produces toxic by-products such as chlorine and toxic ash containing heavy metals. This pose serious health hazards to human society and the environment at large (Karen, 1996; WWW, 2011)

Floods that have occurred in recent times in different parts of the world have been linked in part to the blockage of river channels, drains and strategic routes of flood flow by refuse (Abaje & Giwa, 2005; Olofin, 2010). For example, the floods that claimed hundreds of lives and property worth millions of naira in Ibadan, Kano and Lagos states in Nigeria in 2011 have been attributed to heavy heaps of refuse which blocked the flood routes and forced the flood to overflow and spread into residential areas. (View finder News July, 2011; Daily Trust July, 2011).

MATERIALS AND METHOD

Study Area

Kano metropolis is the third largest city in Nigeria after Lagos and Ibadan respectively, and the largest in the African savannah region. Kano metropolis is located between latitude ($22^0 5N^I$ to $12^0 40^I N$ and longitude $8^0 35^I E$ to $8^0 45^I E$) east of the Greenwich Meridian; that is relatively at the center of Kano Based on the 2006 census, the population of Kano metropolis is about 4,128,820 with a density of about 6,037 persons per km^2. In the current year 2012, the estimated population has risen to about 5 million with a density of 7242 persons per km^2. Even though the population is not evenly distributed, the settlement pattern has been characterized by two categories based on population density.

The first category is the high to medium density settlement which include the old city and the peripheral area respectively. While the second category is the low density settlement of Nassarawa, Tarauni and Hotoro Government Reserve Areas (G.R.A), Kabuga, Kundila, Jaoji, Darmanawa and Mariri housing estates, among others. The old city which is the most densely populated area in the metropolis has a unique cultural set up that reflects the people's religious be life (Islam).State. The metropolis occupies an area of about $683km^2$, with an area distance of 19km from east to west and about 15km from north to south. The metropolis is made up of eight Local Government Areas. These are Dala, Fagge, Gwale, Municipal, Nassarawa, Tarauni, Kumbotso and Ungogo LGAs.

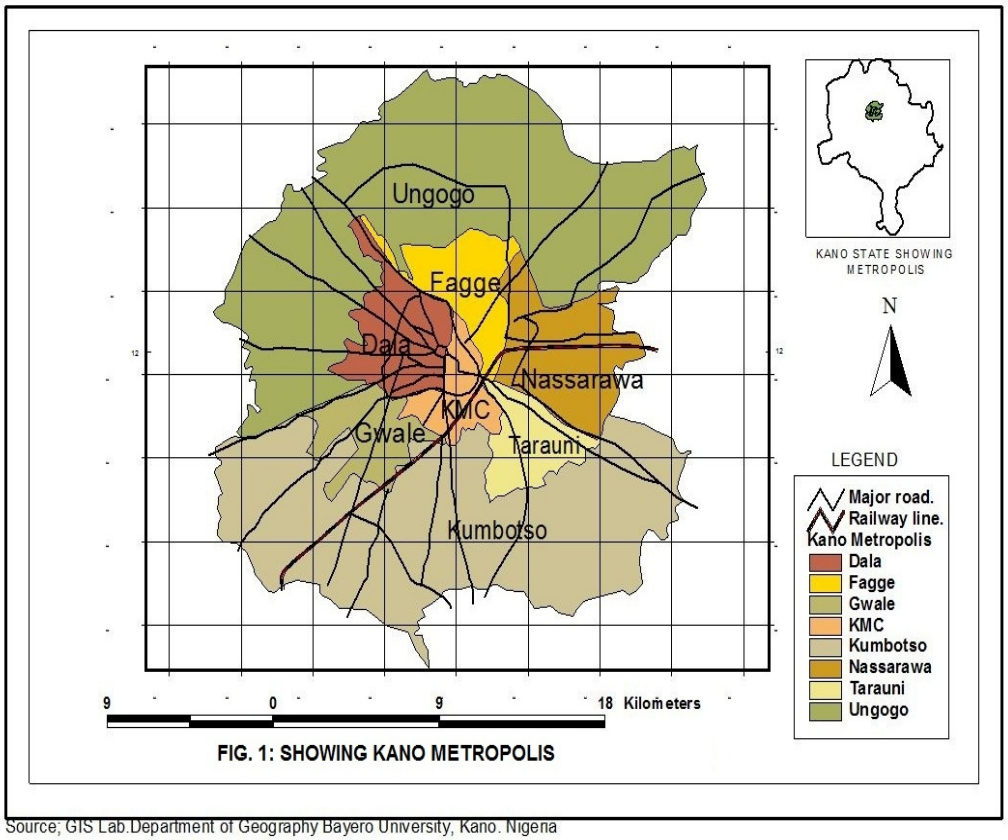

Figure 1. Showing KANO Metropolis

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Data Collection Procedure

For the purpose of avoiding bias and ensuring higher degree of precision, accuracy and reliability, an 8 percent range of acceptable sampling error was chosen for this study at 95% confidence level. By this, a 150 sample size was yielded by applying the general sample size formula for estimating population proportion. The samples involved in the study were therefore not dependent on the total population size of Kano metropolis but on a statistical probabilistic estimation. Nonetheless, the 150 sample is representative of the entire population of the metropolitan Kano. The 150 respondents used in the study were randomly selected from 12 randomly selected wards in the six selected administrative zones within Kano metropolis; Dala, Fagge, Gwale, Municipal, Nassarawa and Tarauni, with 25 individuals from each zone. The inferential statistics used in this study was the non-parametric Pearson's chi-square [x^2] statistical analysis and bivariate correlation analysis.

RESULTS AND DISCUSSION

Full meanings of the abbreviations used in some tables are given below.

BTW - Bottled table water

SPB - Soft drinks in PET bottles

CND - Canned drinks

SPW - Satchel pure water

BMD - Bottled milk drinks

PBJ - Plastic bottled juice

SGB - Soft drinks in glass bottles

Others are D - Dala, F - Fagge, G - Gwale, M - Municipal, N - Nassarawa, T - Tarauni.

Hypothesis Testing

Hypothesis One

H_O: There is no spatial variation in consumers preference for drinks packaged in PET bottles in Kano metropolis

H_A: There is spatial variation in consumers preference for drinks packaged in PET bottles, in Kano metropolis.

Table 1. Contingency Table

S/N		D	F	G	M	N	T	Row Total
1	Bottle table water	17	14	16	21	19	16	103
2	Soft drinks in PET bottle	14	15	18	18	21	13	99
3	Bottled juice	21	22	23	20	18	19	123
4	Bottled milk drinks	14	16	12	18	17	15	92
	Colum Total	66	67	69	77	25	63	417

P.05, X^2cal 6.119, X^2crit 24.996, Df = 15

Decision Rule/Interpretation

The calculated X^2 value (6.119) is less than the tabulated critical X^2 value (24.996) at P.05 at Df = 15. This indicates that there is no difference or variation in the pattern of consumers preference for drinks packaged in PET bottles in all the various areas (LGAs) in Kano metropolis. The null hypothesis (H_O) is therefore upheld while the alternative hypothesis (H_A) is discarded.

Observation from the above table also shows that the frequency scores for each of the locations was high (above half number of the sample in each zone) indicating that the rate of preference or

consumption is high in all the areas. The statistical testing result can therefore be said to confirm both the spatial pattern of consumption as well as the rate of consumption/preference for the product. Based on this fact therefore, it is concluded here that the pattern and/or rate of generation of PET bottle waste was not different in all the eight administrative zones within Kano metropolis.

Hypothesis Two

$H_{O:}$ Consumers of PET bottle products in Kano metropolis are generally not unaware of the implication of consuming the product

$H_{A:}$ Consumers of PET bottle products in Kano metropolis are generally unaware of the implication of consuming the product.

Table 2. Contegency Table

S/N	Location	Aware	Not aware	Row-Total
1	Dala	18	7	25
2	Fagge	14	11	25
3	Gwale	16	9	25
4	Municpal	18	7	25
5	Nassaarawa	19	6	25
6	Tarauni	15	10	25
7	Colum-Total	100	50	150

P.05, X^2cal 3.49, X^2crit 11.07, Df = 5

Decision rule/Interpretation

The calculated X^2value (3.49) is less than the tabulated critical X^2 value (11.07) at P.05, df = 5. This indicates that consumers are generally aware of the implication of consuming the product. The null hypothesis (Ho) is therefore upheld while the alternative hypothesis (H_A) is discarded.

On the basis of the results therefore, it is concluded here that the consumers are generally aware of the socio economic and environmental implications of consuming the products especially with respect to solid plastic waste management in their neighborhoods. It is also observable from the table that the percentage of awareness score is two times greater than the score for the unaware respondents. This basically logically affirms the fact that majority of the respondents are not unaware of the implication of consuming PET bottle products.

Hypothesis Three

H_O: There is no relationship or positive correlation between consumers' awareness of implication of consuming drinks packaged in PET bottle and their preference for the product.

H_A: There is a relationship or positive correlation between consumers' awareness of implication of consuming drinks packaged in PET bottle and their preference for the product.

Table 3: Correlation Analysis Table

Locations	X(Aw)	$x-\bar{x}$	Y(Cs)	$y-\bar{y}$	$(x-\bar{x})^2$	$(y-\bar{y})^2$
Dala	18	1.3	66	-3.5	1.69	12.25
Fagge	14	-2.7	67	-2.5	9.29	6.25
Gwale	16	-0.7	69	-0.5	0.49	0.25
Municipal	18	1.3	77	7.5	1.69	56.25
Nassarawa	19	2.3	75	5.5	5.29	30.25
Tarauni	15	-1.7	63	-6.5	2.89	42.25
6	100	-0.2	∑X=417	0	19.34	147.5
$\bar{X}$ =16.7		$\bar{Y}$ =69.5				

x = Awareness, y = Consumption, r_p= 0, * No Relationship

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Interpretation

The coefficient of correlation obtained from the analysis above is 0. This indicates that the there is obviously no relationship between consumers' awareness score and their preference or consumption of drinks packaged in PET bottles. This invariably implies that consumer's awareness of the consequences of their action does not stop them from continuing demanding for or consuming the product. It is therefore concluded here that consumerism (consumers' culture) is the major factor or problem of PET bottle waste generation. This is because as the consumers cannot control their urge for the product, more PET bottle wastes are being turned out from their consumption of drinks packaged in the material.

Hypothesis Four

H_0: There is no relationship between income status of consumers and consumption or preference for PET bottle products.

H_A: There is a relationship between income status of consumers and consumption or preference for PET bottle product.

Table 4: Relationship between Income Status of Consumers and Consumption of PET Bottle Products

Income levels	Inc	Csp	Inc_r	Csp_r	Inc_r-Csp_r	d^2
0 – 40000	63	96	1	2	-1	1
40001-80000	48	165	2	1	1	1
80001-12000	18	72	3	3	0	0
120,0001-100,000	6	24	5	5	0	0
160004-200000	7	28	4	4	0	0
200001-240001	5	20	6	6	0	0
240001,280000	3	12	7	7	0	0
280,001+	0	0	8	8	0	0
	150	417				$\sum d^2 = 2$

$r_s = 0.9$, * Significant (very strong) Relationship

Interpretation

The coefficient of correlation shows that there is very strong positive relationship between income status of consumers and consumption of drinks packaged in PET bottles, at least by 90%. The alternative hypothesis is therefore upheld while the null hypothesis is discarded. It can be observed from the table above that the consumption/preference for PET bottle products varies almost directly with the income status scores but the frequencies of preference is also high for all income levels. This means however that although income status correlates with consumption of PET bottle products, the products are still more affordable or preferred/consumed by all income groups.

It is therefore concluded on the basis of this observation that the consumers generally have both the propensity and capacity to buy, and that the current rate of PET bottle waste generation would remain (at least) as it is, as long as the observed consumption status remains.

CONCLUSION AND RECOMMENDATION

The conclusion that can be drawn from these findings is that increase in the consumption of drinks packaged in PET bottles is the major cause of PET bottle waste generation and that it is creating some burdensome economic, environmental and social problems in the metropolis. Uncontrolled consumerism, unregulated production and circulation of the products, and improper disposal and management of the final waste output have been identified as major contributing factors.

In view of correcting the problems identified in this study, the following suggestions are recommended for adoption by households, individuals and concerned authorities including the government in Kano metropolis.

1. People should learn to control their desire and resist the pressure or allow reason to guide their choice making and consumption of drinks products. They should rather avoid unnecessary buying and consumption of drinks packaged in PET bottles since they are aware of its implication on the environment. Buying or consuming only what is needed at a time and choosing only environmentally friendly alternative (package) such as those packaged in glass bottle which do not normally add to public waste stream would go a long way in reducing the increase of waste generation associated with PET bottle products.
2. Public waste managers should endeavour to ensure regular collection and evacuation of waste PET bottles from streets and dumpsites, and design a better method of properly managing the waste.
3. Product designers and manufacturers should see themselves as stakeholders in the environmental management responsibility and therefore should not allow profit maximization to overtake their sense of responsibility. They should ensure that their product design and production focus attention on the production of environmentally friendly packages. Manufacturers should also as a matter of responsibility set up more recycling plants to reabsorb and recycle the waste emanating from public consumption of their products. This will also contribute in reducing the waste burden on the environment within the metropolis.
4. Government needs to review and re-design its economic, industrial and environmental policies to take into consideration measures of checking the proliferation of PET bottle packaging products which are now taking over the market in the metropolis. The government should regulate the manufacturer's production and circulation (distribution) of PET bottle products and ensure that those manufacturers producing PET bottle drinks set up recycling plants in their industrial sites in the metropolis. The manufacturing industries should also be made to buy back the waste bottle from the public as a way of reducing the economic burden on government budget (for public municipal waste management) and households' cost of waste disposal. This will help in minimizing the environmental and social effects of waste bottle refuse in the metropolis.
5. Government, Non-governmental Organizations and concerned institutions should as a matter of necessity organize more public enlightenment programmes to educate the public more on the need to always consider the environment first in their decision making as to what kind of container or package they should go for when buying their choice drinks. This perception and attitudinal management strategy has the potential to reduce the rate of consumption of PET bottle products and thereby reducing the waste generation coming from the consumption and/or consumer behaviour.
6. Social, corporate, educational and research institutions in Kano State also have role to play in minimizing the rate of consumption of the product (PET bottle products) in the state especially in the metropolis. They can assist in carrying out more researches and public, enlightenment and, also in supplying the government with useful research information (report) that can facilitate positive policy making in respect of the trend.

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