EVALUATION OF THE POTENTIAL ECONOMIC VALUE OF PET BOTTLED WATER SCRAPS IN ENUGU URBAN

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Abstract

This paper assessed the potential economic value of PET Bottled Water Scraps (PBWS) that constitute a large proportion of municipal solid waste in Enugu Urban, Nigeria. It investigated the volume and typology of PET Bottled Water (PBW) produced and placed in the market in Enugu Urban and estimated the scale of potential economic value of the Scraps. Field Survey and key informant interviews were utilized to collect primary data on the typology, volume and cost of PBWS. Data collected was analyzed using simple descriptive statistics. Findings revealed that 75cl PBW is more predominate in the market and the potential cumulative economic value of PBWS (50Cl, 75Cl and 150Cl) in 2019 will be N320, 371, 800 and N6.2 billion ($17.2 million) in the next ten years. The paper noted that government investment in PBWS will generate the much needed revenue to finance capital projects in the state while creating employment and sustaining the environment. The paper recommended the investment in recycling infrastructure and integration of scavengers in a formal and legal coordinated collection and management of PBWS to optimize its economic potential and mitigate its environmental externalities.

Key words: *Deposit Refund System (DRS), Polyethylene terephthalate (PET), Economic Value, Plastic Bottled Water Scrap (PBWS).*

1.0 Introduction

Plastic consumption has increased with poor waste management and sanitation practices in developing countries. In Nigeria, plastic consumption has grown by 7.8 per cent from 578 kilo tonne in 2007 to 1.229 Kilo tonne in 2017 and is estimated to be 1.533 kilo tonne in 2020 (Asoko, 2017). Plastic Production has also increased at a rate of 13.9 per cent per annum with plastic packaging especially Polypropylene and Polyethylene Terephthalate (*PET*) accounting for 53.8 per cent amongst other plastic uses (EuroMap, 2017). However, the amount of the recovered end of use of these plastics and optimization of the scraps for socio-economic benefits is insignificant in Nigeria.

Nigeria with an estimated population of over 162 million (the World Bank, 2018) currently generates huge amount of PET scraps. Studies focusing on Municipal Solid Waste management (MSWM) in Nigeria reported that 45 per cent of the country's population reside in urban areas and generate about 41 thousand tons of Municipal Solid Waste (MSW) with Plastic scrap accounting for a large proportion of the waste (Oyeshola, 2017; Nzeadibe, 2009; Babade, undated). These wastes are indiscriminately dumped in waste bins or littered where illicit waste pickers (Scavengers) recover the re-usable part of waste scraps especially PET bottles and the inferior waste are either left in open dumps or transported to landfill sites without methane capture. In 2018 it was reported that lots of poor masses scavenge on them for a living. The plastic wastes in particular find two paths; approximately half go back to homes and the other half to recycling plants. Either of these paths leads to deadly consequences (Bakare, 2018).

Several scholars have raised the challenges in the management of plastics as one of the most toxic pollutants of present time. Being composed of toxic chemicals and most importantly a non-biodegradable substance, plastic pollutes earth and leads to air pollution and water pollution. This also mixes with food chain effecting the Environment, Humans and animals (Koushal, Sharma, Sharma, Sharma and Sharma, 2014). PET bottles especially reused ones have been shown to adhere microbial cells (Jones, Adams, Zhdan, and Chamberlain, 1999; and Kreigel, 2015) and contaminate liquid with antimony, Bisphenol A (BPA), Acetaldehyde, Phthalates, Di (2-ethyl-hexyl) phthalate (DEHP), Di-n-butyl phthalate (DBP), Disononyl phthalate (DiNP) which some are suspected carcinogens and are known to be toxic to the liver, kidneys, and reproductive organs (Shotyk, Krachler and Chen, 2006; Shotyk and Krachler, 2007; Mercola, 2013; Keresztes, Tatár, Czégény, Záray, and Mihucz, 2013; Kregiel, 2015).

Despite these challenges of re-use and disposal of PET bottled water scraps (PBWS), the economic value derived from the sales of PBWS play a dominant role in the sustainable livelihood of scavengers in Enugu Urban. Ignoring scavengers of PBWS in the waste management plan could result to unsustainable interventions ultimately exacerbating the deficit in urban environmental service delivery and sustenance of the urban poor (Nzeadibe, 2009). Thus, investigating the value of PBWS amongst scavengers is imperative to amicable devise socio-economic management measures that are hygienic to man and environment while ameliorating the economic benefits of the scraps for scavengers, government and other stakeholders.

Though economic instrument such as Deposit Refund Systems has been significant in achieving these feats, availability of information on the cost, benefits and information of the scraps are pivotal for setting-up the system (Backman, 1984). It is therefore, against the background of this study to evaluate the potential economic value of PBWS in Enugu Urban.

2.0 Literature Review

2.1 Plastic Consumption and Management in Nigeria

According to the National Agency for Food and Drug Administration and Control (NAFDAC), Nigeria's plastic and packaging sector has grown rapidly in recent decades, from around 50 companies at its inception in the 1960s to more than 3,000 manufacturers currently (Aussenwirtschaft, 2014)**.** Plastic consumption in the country increased annually from 2008 to 2015 to 7.2 per cent with per capita consumption of 5 per cent annually over the past ten years from 578 kilo tonne in 2007 to 1.229 Kilo tonne in 2017 and is estimated to be 1.533 kilo tonne in 2020.

EUROMAP (2016) reported that plastic production grew by 13.9 per cent annually over the past ten years, from 120 kilo tonne in 2007 to 442 kilo tonne in 2017 and is estimated to be 513 kilo tonne in 2020. According to the report, 53.8 per cent of consumption is accounted for by packaging, 16.3 per cent by construction, 5.7 for automotive and the remainder by various industries. The growth of these packaging will logically lead to correlative increase in plastic package waste. This aspect has been relatively silent in the country. Whereas, the by-product of this volume of plastic waste can be put to productive uses if properly managed or create more environmental problems and expensive clean -up cost in the future if poorly managed.

Studies focusing on Municipal Solid Waste Management (MSWM) in Nigeria have reported that a high percentage of MSW is: uncollected, collected and openly dumped, collected and conveyed to open dump sites, or collected and transported to landfill sites without methane capture where some informal recovery for recycling occurs and final treatment is by open incineration and consequent emission of Greenhouse gas (GHG) (Abumere, 1983; Bammeke and Sridhar,1989; Sha'Ato, Aboho, Oketunde, Eneji, Unazi, 2007; Coker, Sangodoyin, Sridhar, Booth, Olomolaiye, 2009; Nzeadibe 2009; Ogwueleka, 2009; Solomon, 2009; Nabegu, 2010; Nabegu, 2011; Oyeshola, 2017). An inventory of GHG emissions in Nigeria based on a gross population of 96.7 million carried out in 1994 estimated the total methane emissions as 5.9 Tg CH4 (Oyeshola, 2017). The MSW sector accounted for approximately 4 per cent of the total amount. Although this contribution can be considered low relative to methane emissions from other sectors, given her projected population increase as well as the established correlation between population increase and MSW generation, methane emissions from the MSW sector should be given serious consideration.

2.2 Economic Resource Value of PET bottles

Several studies have validated empirically the value of PET bottle scraps when managed using economic instrument such as Deposit Refund. According to Dewey *et al* (2011) analysis of a Beverage Container Deposit Refund System in 10 states in America showed that return rate of 10 cents had a return rate of 97 per cent with consequent economically beneficial recycling.

Hogg et al (2010) reported that the overall effect of the introduction of a DRS in the United Kingdom is projected to lead to an increase in the number of jobs available by between 3,000 and 4,300 Full Time Employments (FTEs). In Minnesota-USA PET bottles return and refund amongst

other packaging created 1,438 recycling refund system jobs; 4 state law enforcement and regulatory agency jobs; and undetermined potential for in-state recycling manufacturing jobs (Reclay StewardEdge, 2014).

In Nashfa's (2016) study on the law passed on PET bottles in Palau showed that collection and refund of PET bottles has been self-financing because the high deposit rate allows the government to refund, operate, and save extra money at the Recycling Fund, to cover the expenses of waste management activities. Lavee (2010) conducted a complete cost-benefit analysis for a deposit–refund program for beverage containers in Israel. The results of the analysis revealed that the program is highly beneficial to the national economy, with total benefits exceeding total costs by slightly over 35 per cent.

According to Alli (2016), PET bottle recycling in Lagos - Nigeria currently generates jobs across value chains. Investigations by the author revealed that new industries which focuses on recycling of PET bottles is being driven by multinational companies operating under the umbrella called Nigerian Beverage Alliance in partnership with Alkem Nigeria Ltd. The project employs an estimated 1,800 people with many earning N34,000 monthly. The synthetic fiber produced from these scraps supports various industries in producing textiles, mattresses, pillows, sofas, roofing sheets and insulation for building in Nigeria.

Again, from a pilot survey by Nzeadibe (2009), daily earning of scavengers is between N800 and N1, 300 naira per day. Recent findings reports that scavengers sell a PET bottle in Lagos at N5 and make between N800 – N1, 500 each day. This income is more than the Nigerian government minimum wage of N18, 000 per month.

3.0 Study Area

Enugu urban is located in Enugu State, Nigeria within latitudes 6°27′9.60″N and 6°27′9.60″N and longitudes 7°30′37.20″E and 7°30′37.20″E (Nnam, Maduako, Nnam Uchechukwu, and Chukwubueze, 2014). The city core has an area of about 90 km2 (Nnam et al, 2014) and comprises of three local government areas namely- Enugu East, Enugu North, and Enugu South (Enete and Alabi, 2012) (figure 1). Enugu Urban has an average temperature of 32.5°C (Nigeria Bureau of Statistics, 2011) and a mean annual rainfall of 1200mm to 1800mm and a relative humidity ranging between 50 per cent and 80 per cent (Okwu-Delunzu, Chukwu, Nwagbara, and Osumadewa, 2015). The population of the study area rose from 3,170 inhabitants in 1921 to 35,000 in 1945 (Okwu-Delunzu et al 2015). According to the Nigerian Bureau of Statistics (2006), the latest census of Enugu Urban is 717, 281 people, with Enugu North comprising of 242,140 people; Enugu South 198,032; and Enugu East 277,119. The population is projected to be 1,388,412 people for 2018 at a growth rate (r) of 2.83 per cent using the European Commission (2015) population projection model.

The city hosts eight tertiary institutions - University of Nigeria Enugu Campus (UNEC), Enugu State University of Science and Technology (ESUT) Annex, Caritas University, Godfrey Okoye University, Coal City University, Institute of Management and Technology, Enugu State College of Education and OSISA Tech; drink and plastic manufacturing industries - 7up Bottling Company, Nigerian Breweries, The Lord's Table Water, 042, Aqua Rapha, Top Hill Waters, Jasmine Waters, Ivy Waters, Bejoy Waters and Gossy Waters. Innoson Plastics - an indigenous plastic manufacturing Industry is also located in the city; prominent commercial centres - Ogbete, Kenyetta , Mayor, Gariki, and New Market; six major departmental stores - Shoprite, Games, SPAR, Roban, Eastern Shop and Pentagon , and several retail stores and corner shops in Enugu Urban. Major Scavenger harbors in

Enugu are Ugwuaji (Independence Layout phase II), Okpara Avenue (off Subway), Trans-Ekulu (Jim Nwobodo Avenue), Nkpor street, (Abakpa), Edozie Street (Uwani), Udoma street (New Haven) and Akwatta.

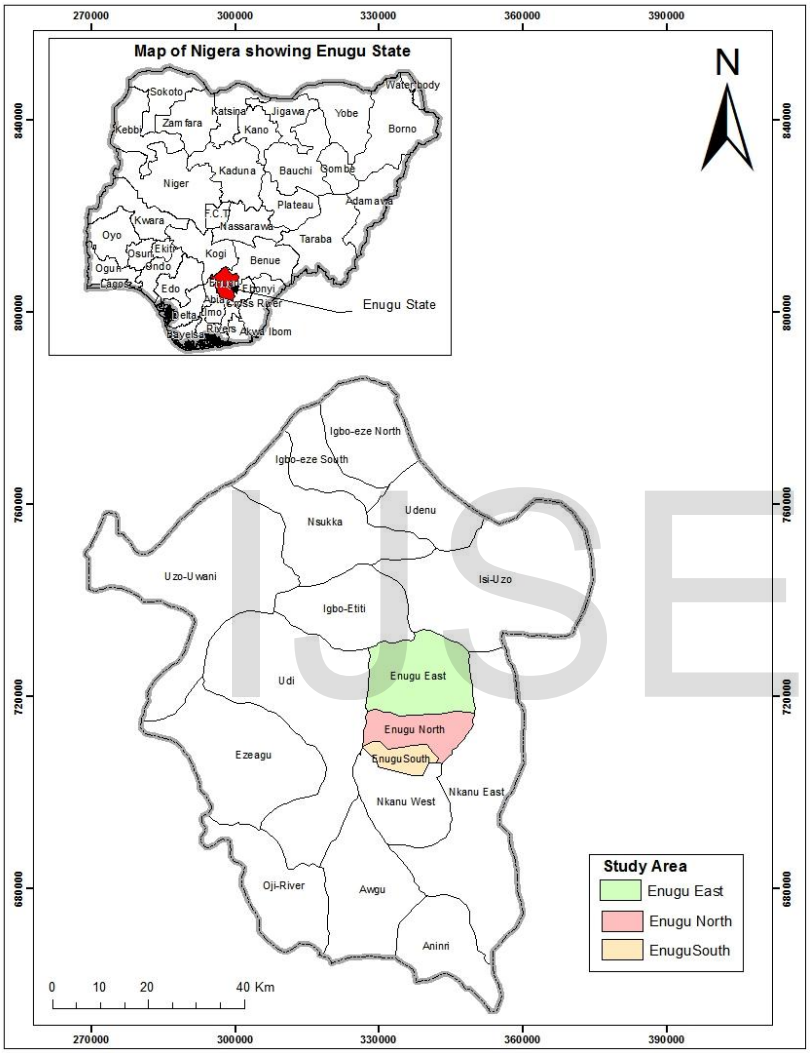

Figure 3.1: Map of Enugu State and local government Areas Showing the Study Area.
Source: Okwu-Delunzu, *et al*, 2015

PET bottled water scraps for sale in Akwatta, Ogbete main Market

PBWS and other packages for sale at Subway

PBWS for sale at Edozie street

PBWS for sale at Ugwuaji

4.0 Method of the Study

Data of brands, sizes and volume of PBW produced in Enugu was collected from randomly selected retail, wholesale stores and access granted PBW depots located in the three local government areas that comprise Enugu Urban (Table 1). Data of the price of the different brand sizes of PBWS was collected by Key informant interview of scavengers in all the located scavenger depots in Enugu Urban: Off subway Road (Okpara Avenue), Jim Nwobodo Avenue (Trans-Ekulu), Nkpor Street (Abakpa), Edozie Street (Uwani), Akwatta (Ogbete) and Udoma Street (New Haven). Data collected were analyzed using simple descriptive statistics.

To identify the average number of retail shops in Enugu Urban, a pilot survey was conducted in the randomly selected locations in the three local government areas that comprise Enugu Urban. It was revealed that for every 12 households, there is at least a retail shop. With a projected population of 1,388,412 people in 2018 and an average household size of six persons according to the Nigeria Bureau of Statistics (2006), a total of 19,284 retail shops were estimated.

Table 1: Sampled retail and wholesale Stores and access granted Depots of PBW

s/n	Local Government	Locations	No of retail and wholesale Stores	No. of PBW Depots
1	Enugu North	**Ogui Road** Owerri Road, Church Road, Sub-way **Ogbete** Old Park, Holy Ghost, Whole Sale Lines, **New Haven** Nanka, New Haven Market, Markus Garvey	15	3
2	Enugu South	**Uwani,** Zik Avenue Onwudiwe/, Ozanichebe **New Layout** Kenyatta Mayor Gariki	15	2
3	Enugu East	**Abakpa** **Emene**	15	1

Total	3		45	6

Source: Researchers' Field Survey, 2019

5.0 Data Analysis

5.1 Brand Size and Volume of Plastic Bottled water produced and marketed in Enugu Urban

In Table 2 below, Aqua Rapha brand of PBWS accounts for 29.9 percent of bottled water supplied in Enugu Urban market followed by Ivy waters with 11.9 per cent, Aquafina with 9.5 percent and Rovia with 8.5 percent. The least is 042 with 0.7 per cent. In figure 2, 75Cl PBW is more predominant in the market accounting for 561,900 bottles per week followed by 50cl with 97,461 bottles and 150cl with 5000 bottles per week.

Table 2: Brands, Sizes and average number of Plastic Bottled water Produced and marketed in Enugu

s/n	Bottled Water brand	Sizes in centiliter (Cl) and average number of bottles recorded per week				Total Bottles per week	percentage
		50cl	75cl	100cl	150cl		
1	Top hill	3,600	28,600	-	680	32,800	4.9
2	De Lords	6,400	21,600	-	-	28,000	4.2
3	Aquafina	-	64,000	-	-	64,000	9.5
4	Aqua Rapha	86,400	115,200	-	-	201,600	29.9
5	Jasmine	-	33,600	-	-	33,600	5.0
6	042	-	4,800	-	-	4,800	0.7
7	Cykris	-	38,400		-	38,400	5.7
8	Denco	-	21,600			21,600	3.2
9	Ivy	11,016	64,800	-	4,320	80,136	11.9
10	Own Waters	-	32,600	-	-	32,600	4.8
11	Rovia	-	57,600	-	-	57,600	8.5
12	Ex bon	-	22,800	-	-	22,800	3.4
13	Mama Koo	-	18,900	-	-	18,900	2.8
14	Kanih	-	14,800	-	-	14,800	2.2
15	Deli waters	-	22,600	-	-	22,600	3.4
	Total	97,461	561,900	0	5,000	674,236	100

Researchers' field survey 2019

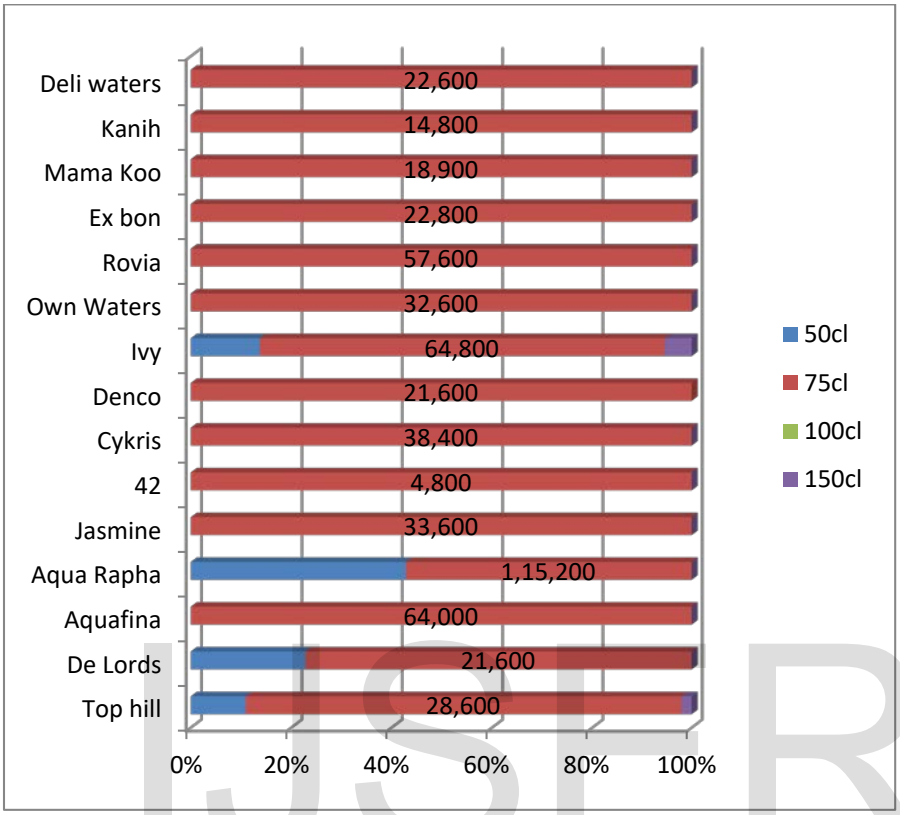

Figure 2: Multiple Bar Charts showing volume of PET bottled water brands placed in the market in Enugu Urban according to size of PBW

5.2 Extrapolated Volume of PBW and PBWS in Enugu Urban

In Table 3 below, the projected cumulative of PET bottled water that will be placed in the market in 2019 at13.9 per cent annual increase in the rate of production according to Euro Map (2017) report, is 35,063,672 units of plastic bottles. In the next ten years it is estimated to be 674,743,561. 75Cl PBW is estimated to increase faster amongst the three dominant sizes in Enugu Market if the rate of production remains the same (figure 3) accounting for 8,433 tonnes of PBWS in the next ten years of the total estimated 11,414 tonnes (11.4 kilo tones)The increase in this figure 3, the exploded pie chart shows that in the next ten years, the tonnage of plastic bottled water produced and sold in Enugu will be 11,414 tones which is equivalent to 11.4 kilo tones (figure 4).

Table 3: Extrapolated Volume at 13.9 percent of Plastic bottled water scrap according to size from 2019 to 2028 in Enugu Urban

s/n	Year	Plastic bottle size			Total
		50cl	75cl	150cl	
1	2019	5,585,632	29,218,400	259,640	35,063,672
2	2020	6,362,035	33,279,758	295,730	39,937,523
3	2021	7,246,356	37,905,644	336,836	45,488,836
4	2022	8,253,599	43,174,529	383,656	57,166,574
5	2023	9,400,849	49,175,789	436,984	65,112,728
6	2024	10,707,567	56,011,224	497,725	74,163,398
7	2025	12,195,919	63,796,784	566,909	84,472,110
8	2026	13,891,152	72,664,537	645,709	96,213,733
9	2027	15,822,022	82,764,908	735,463	109,587,442
10	2028	18,021,283.1	94,269,230	837,692	124,820,096
	Total	107,486,414	562,260,803	4,996,344	674,743,561

Researchers field survey 2019

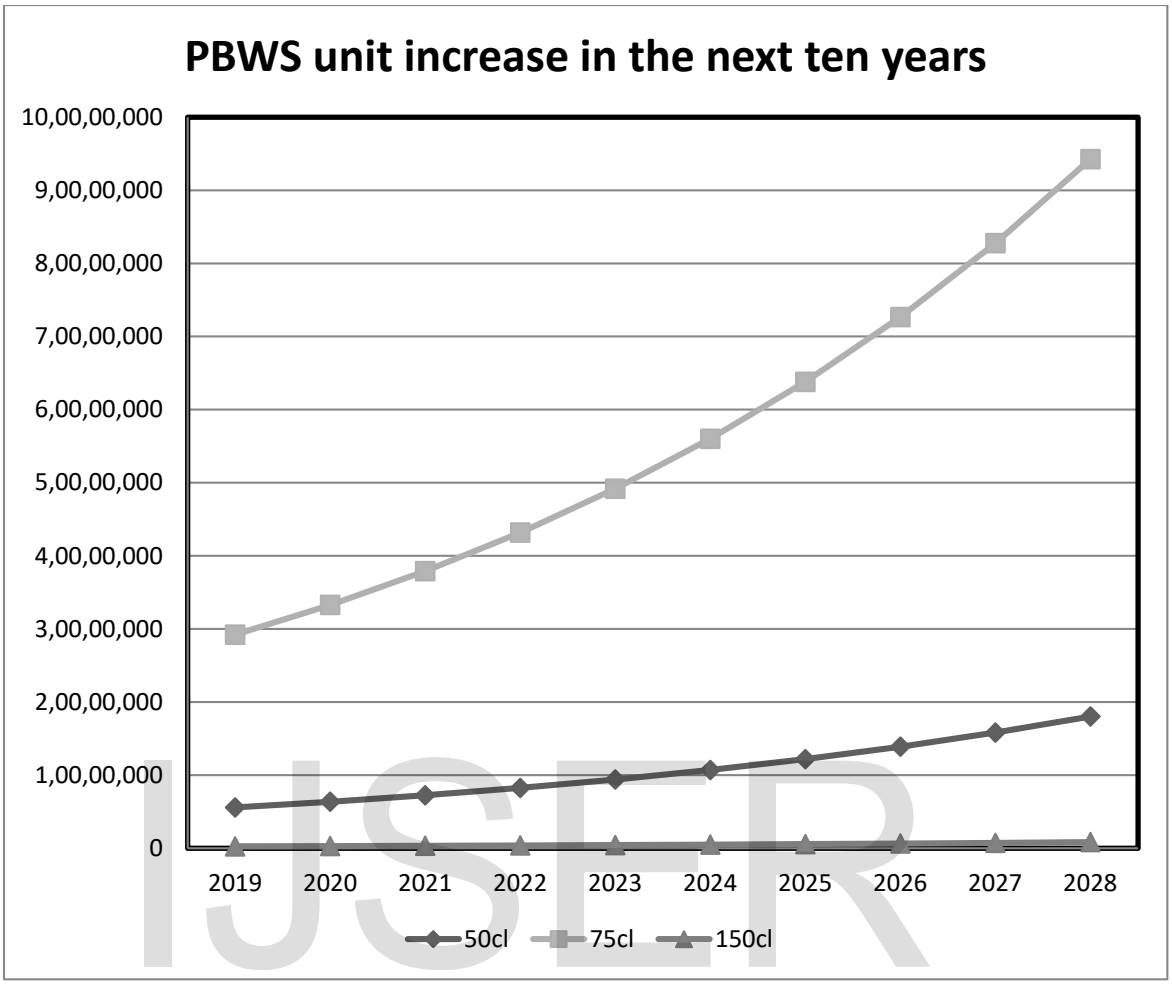

Figure 3: PBWS increase in the next ten years

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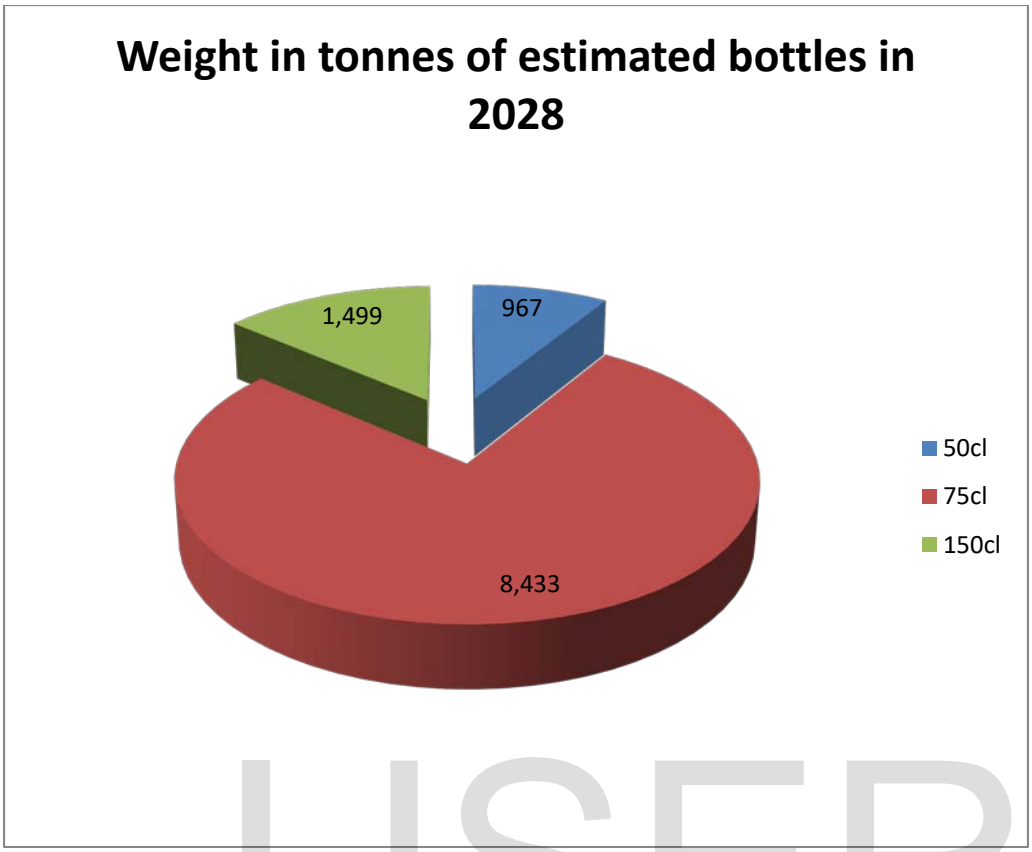

Figure 4: Pie Chart showing volume of plastic bottle sizes in tones in the next ten years

5.3 Potential End Resource/Economic Value of Recovered PBWS in Enugu Urban

Table 4: Estimated number of plastic bottled water produced and placed in the market for year 2019 and their end resource value

s/n	Bottled Water brand	PET size 50cl	Estimate* volume PET bottles in 2019	@ N5	PET size 75cl	Estimate* volume in 2019	@ N10	PET size 150cl	Estimate* volume in 2019
1	Top hill	3,600	187,200	936,000	28,600	1,487,200	14,872,000	680	35,000
2	De Lords	6,400	332,800	1,664,000	21,600	1,123,000	11,230,000	-	-
3	Aquafina	-	-	-	64,000	3,328,000	33,280,000	-	-
4	Aqua Rapha	86,400	4,492,800	22,464,00	115,200	5,990,400	59,904,400	-	-
5	Jasmine	-	-	-	33,600	1,747,200	17,472,000	-	-
6	042	-	-	-	4,800	249,600	2,496,000	-	-
7	Cykris	-	-	-	38,400	1,996,800	19,968,000	-	-
8	Denco	-	-	-	21,600	1,123,000	11,230,000	-	-
9	Ivy	11,016	572,832	2,864,160	64,800	3,369,600	33,696,000	4,320	224,640
10	Own Waters	-	-	-	32,600	1,695,200	16,952,000	-	-

11	Rovia	-	-	-	57,600	2,995,200	29,952,000	-	-
12	Ex bon	-	-	-	22,800	1,185,600	11,856,000	-	-
13	Mama Koo	-	-	-	18,900	982,800	9,828,000	-	-
14	Kanih	-	-	-	14,800	769,600	7,696,000	-	
15	Deli waters	-	-	-	22,600	1,175,200	11,752,000	-	
	Total		5,585,632	27,928,160		29,218,400	292,184,000	5000	259,640

Researcher's field survey, 2019
*multiplied by 52 weeks

In Table 4 above, the estimated number of PBW that will be placed in the market in Enugu Urban in 2019 is 34,809,037 bottles with a cumulative end resource value of N320,371,800 for the PBWS. In the next ten years (2028), 75Cl PBWS will be close to 100 million units , 50cl with 19 million units and 150cl with 838,000 units giving an estimated cumulative of 674,743,561 units of PBWS (Table 5). Hence, the estimated value of the PBWS in 2028 is N6, 232,400,000.

Table 5: Extrapolated volume and estimated economic value of PET bottled water scrap (PBWS) from 2019-2028

s/n	Year	Plastic bottle size						Estimated volume of plastic
		50cl	Economic value @N5 (million)	75cl	Economic value @N10 (million)	150cl	Economic value@N15 (million)	
1	2019	5,585,632	27.9	29,218,400	290	259,640	3.9	35,063,672
2	2020	6,362,035	31.8	33,279,758	330	295,730	4.4	39,937,523
3	2021	7,246,356	36.2	37,905,644	380	336,836	5.0	45,488,836
4	2022	8,253,599	41.3	43,174,529	430	383,656	5.8	57,166,574
5	2023	9,400,849	47.0	49,175,789	490	436,984	6.6	65,112,728
6	2024	10,707,567	53.5	56,011,224	560	497,725	7.5	74,163,398
7	2025	12,195,919	61.0	63,796,784	640	566,909	8.5	84,472,110
8	2026	13,891,152	69.5	72,664,537	730	645,709	9.7	96,213,733
9	2027	15,822,022	79.1	82,764,908	830	735,463	11.0	109,587,442
10	2028	18,021,283	90.1	94,269,230	940	837,692	12.6	124,820,096
	total	107,486,414	537.4	562,260,803	5620	4,996,344	75	674,743,561

Researcher's field survey 2019

6.0 Discussion of Findings

The estimated number of PBW produced and placed in 45 retail/wholesale stores and 6 depots in Enugu Urban market in 2019 is 34,809,037 bottles. With an annual production growth rate of 13.9 per cent according to EUROMAP, the number is expected to hit 674, 743, 651 bottles in 2028. It can thus be assumed that with an estimated number of 19,284 retail/wholesale shops in Enugu, the expected number of PBWS in the next ten years will be 255 billion bottles. This growth will logically lead to correlative increase in PBWS externalities if not properly managed. However, economic

resource value of PBWS that will be generated in 2019 from 45 retail/wholesale stores and six depots is over N300 million. In ten years (2028) the estimated resource value of the scraps will be N6.2 billion. This can be highly beneficial for Enugu's economy; generating the much needed capital for waste management and infrastructural development as stated by Lavee (2010) and Nashfa (2016).

7.0 Recommendation

Government, non – government organization and institutions need to introduce a system that can incentivize proper management of PBWS that is both hygienic and capable of harnessing its potential economic value. A developed course of Deposit Refund System that captures scavengers and investment in recycling infrastructure is strongly recommended. Sensitization programme on the negative effects of re-using PBWS and their economic value under DRS should be introduced in schools, public and private institutions.

Again, **f**urther studies are needed in the area of: Sachet water production, Aluminum can drinks, Tetra Packs and other variety of drinks in PET bottles - their volume and resource value; assessment of the effect of plastic package drinks on human health; Life Cycle Assessment (LCA) of PET of conversion, recycling and cost of PET bottles is also needed to identify the best option at an opportune cost for re-production of PBWS in Nigeria.

8.0 Conclusion

Plastic consumption especially Polypropylene and Polyethylene Terephthalate (*PET*) have continued to increase to meet the growing world population with undesirable environmental consequences where poorly managed. However, recovery of plastic scraps using Economic Instruments such as Deposit Refund System (DRS) and optimization of the scraps for socio-economic benefits have been significant in recent times. PET Bottled Water Scraps (PBWS) in Enugu Urban is expected to be 255 billion bottle units in 2028. This volume can result to exponential environmental externalities or exponential socio – economic benefits for Enugu urban contingent on the management measures implemented. It is therefore, imperative the government of Enugu State Introduce Economic Instruments deemed fit to ameliorate the benefits and mitigate the externalities of PBWS,

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