Development of Framework for Plastic Waste Management in Enugu Metropolis, Enugu State, Nigeria

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Abstract: **With the increase in plastic waste generation in Enugu Metropolis coupled with its ubiquity and threat to the environment, this study was carried out with the aim of designing a framework for plastic waste management in Enugu Metropolis. The study was carried out through the distribution of questionnaires to members of staff of Enugu State Waste Management Agency (ESWAMA) and residents in the three Local Government Areas that make up Enugu Metropolis which include: Enugu North L.G.A, Enugu South L.G.A, and Enugu East L.G.A. Data collected from the study were analyzed using descriptive statistics. The study revealed that for effective plastic waste management in Enugu Metropolis, the following strategies should be implemented: creation of more environmental awareness, implementation and enforcement of polluters pay principle, implementation of extended producers responsibility, creation of plastic waste recycling centers, the involvement of stakeholders/citizens in plastic waste management policymaking, development of effective policies on plastic waste, the introduction of incentives for plastic reuse, introduction of incentives for plastic recycling, effective monitoring of policies on plastics. These strategies were used to design a framework for plastic waste management in Enugu Metropolis. The study, therefore, recommended that the developed framework be quickly implemented to reduce the quantity as well as the threats of plastic waste.**

I. INTRODUCTION

In the last ten years, due to the increased generation and improper disposal of plastics on land, plastic waste has attracted attention in so many developing countries of which Nigeria is not left out (Vijaya and Seemas, 2012). It accounts for 15% of total waste volume and some of the organics may still be classified as plastic material as a fraction of its production is from plastic materials (Adekomaya and Ojo, 2016). Plastic waste in the environment poses lots of threats to the ecosystem which include loss of aquatic life, blockage of drainage system resulting in flooding, reduction in water and nutrient absorption into the soil, destruction of the aesthetic value of the environment. The problems facing developing countries in the handling of plastic waste are not impossible to solve but they need a concerted effort from all sectors of society (Wasonga, Okuto and Ngugi, 2018). This implies that an all-inclusive approach is necessary for the achievement of any meaningful plastic waste management (Wasonga, Okuto and Ngugi, 2018; Kevin, 2018)

Apparently, various governments across the world have come up with creative policies to mitigate the plastic threat (Sanika and Rashmi, 2019). The most promising solutions that are being adopted in many countries in the world, which have proven successful, include complete ban in Rwanda, plastic tax in Ireland and voluntary initiatives in Australia (Etakong, 2018). In some countries like Bangladesh, Ghana, Rwanda, Washington DC, Uganda, South Africa, Tanzania, and Ethiopia, the prevention of plastic waste generation have been achieved through tax/banning of the use of some types of plastics (Jonathan, 2009; Osinbanjo, 2018; Bashir, 2013). It was noted that price tag to plastic waste could help in converting the problem of plastic waste into opportunity as well as bringing a decline in the consumption of plastic (Ogwo, *et al*, 2013; Ndinwa and Peretomode, 2014; Johane and Martine, 2012). However, deposit-refund system is considered the most applicable and appropriate instrument through which the externalities (such as the recyclability of the packaging of the commodity) can be controlled (Babatunde and Biala, 2010).

To ensure an effective plastic waste management, plastic waste recovery and recycling should be institutionalized and regulated so that the wealth linkage can be mainstreamed with national policies as this will help in environmental protection (Owusu-Sekyere, Issaka and Abdul-Kadri, 2013; Igba and Onaga, 2015). Moreover, the implementation of Plastic Polluter Pay (PPP) can be effective in managing the menace of plastic waste (Urama, Ukwueze and Aneke, 2012).

In Enugu state, the Enugu State Waste Management Authority (ESWAMA) was established to develop and implement policies on the management of solid and liquid wastes that should promote the health and well being of the people. It has the responsibility to ensure effective collection, removal, treatment, and disposal of all kinds of wastes. It also has the mandate to check the illegal dumping and littering of refuse at roadsides, enclosures, streams in neighborhoods and drainage. The agency is empowered to prosecute defaulters of sanitation laws while providing waste management facilities (Titus and Anim, 2014). However, despite various environmental policies in the state, coupled with the efforts of the environmental regulatory authorities like ESWAMA, in the protection of the environment, plastic waste generation remains incessantly unbearable to the tolerant carrying

capacity of our environment (Titus and Anim, 2014). Thus, this study aims at developing a framework for effective plastic waste management.

II. MATERIALS AND METHODS

To generate a plastic waste management strategy for Enugu Metropolis, a well-structured questionnaire was designed to source the opinions of members of staff of Enugu State Waste Management Agency (ESWAMA) and residents in the three Local Government Areas that make up Enugu Metropolis which include: Enugu North L.G.A, Enugu South L.G.A, and Enugu East L.G.A. A total of 450 questionnaires were distributed to respondents. This comprises 126,118 and156 questionnaires distributed to respondents in Enugu North L.G.A, Enugu South L.G.A, and Enugu East L.G.A respectively, and 50 questionnaires distributed to members of staff of Enugu State Waste Management Agency (ESWAMA). Data collected from the study were analyzed using descriptive statistics and were used to design a framework for the management of plastic waste in the area.

III. RESULTS AND DISCUSSION

Going by the responses of respondents and visual observation of what was on the ground, the criteria for choosing the plastic waste management strategies was raised to 70 percent of the weighted mean. Therefore, strategies from 70% and above were adopted as the plastic waste management strategies in the areas.

3.1 Plastic waste management strategies in Enugu North L.G.A

Table 1 shows the responses of respondents in Enugu North L.G.A on plastic waste management strategies. The percent statistics of the weighted mean shows that the suggested plastic waste management strategies include: more environmental awareness creation should be carried out (80.7937%), creation of plastic waste recycling centers (81.5873%), introduction of purchase discount for using reusable plastic products (76.8254%), involvement of stakeholders/citizens in plastic waste management policy making (78.5714%), development of effective policies on plastic waste (70.3175%), introduction of incentives for plastic reuse (74.4444%).

Table 1: Responses of Respondents on Plastic Waste Management Strategies in Enugu- North L.G.A

S/N	Plastic Waste Management Strategies	SA		A		U		D		SD		Mean	Percent
		F	%	F	%	F	%	F	%	F	%		
1	Use of plastics should be banned	7	5.56	12	9.52	16	12.70	39	30.95	52	41.27	2.0714	41.4286
2	More environmental awareness creation should be carried out	57	45.24	42	33.33	9	7.14	11	8.73	7	5.56	4.0397	80.7937
3	Implementation and enforcement of polluters pay principle	29	23.02	25	19.84	27	21.43	32	25.40	13	10.32	3.1984	63.9683
4	Implementation of extended producers responsibility	22	17.46	40	31.75	32	25.40	23	18.25	9	7.14	3.3413	66.8254
5	Creation of plastic waste recycling centers	57	45.24	41	32.54	15	11.91	7	5.56	6	4.76	4.0794	81.5873
6	Introduction of purchase discount for using reusable plastic products	42	33.33	53	42.06	9	7.14	13	10.32	9	7.14	3.8413	76.8254
7	Increase in price of plastic products	12	9.52	21	16.67	10	7.94	66	52.38	17	13.49	2.5635	51.2698
8	Involvement of stakeholders/citizens in plastic waste management policy making	44	34.92	50	39.68	14	11.11	15	11.91	3	2.38	3.9286	78.5714
9	Development of effective policies on plastic waste	29	23.02	49	38.89	14	11.11	26	20.64	8	6.35	3.5159	70.3175
10	Introduction of incentives for plastic reuse	39	30.95	50	39.68	13	10.32	11	8.73	13	10.32	3.7222	74.4444
11	Introduction of incentives for plastic recycling	14	11.11	38	30.16	18	14.29	36	28.57	20	15.87	2.9206	58.4127
12	Introduction of plastic tax	3	2.38	17	13.49	20	15.87	34	26.98	52	41.27	2.0873	41.7460
13	Effective monitoring of policies on plastics	20	15.87	62	49.21	15	11.91	17	13.49	12	9.52	3.4841	69.6825
14	Introduction of plastic charges to customers	7	5.56	25	19.84	6	4.76	46	36.51	42	33.33	2.2778	45.5556
Cluster Mean and Percent												3.2194	64.3878

3.2 Plastic waste management strategies in Enugu South L.G.A

Table 2 summarizes the responses of respondents in Enugu South L.G.A on plastic waste management strategies. The percent statistics of the weighted mean shows that the suggested plastic waste management strategies include: more environmental awareness creation should be carried out (79.1525%), implementation of extended producers

responsibility (70.6780%), creation of plastic waste recycling centers (77.2881%), introduction of purchase discount for using reusable plastic products (74.2373%), involvement of stakeholders/citizens in plastic waste management policy making (75.5932%), development of effective policies on plastic waste (77.4576%), and effective monitoring of policies on plastics (72.3729%).

Table 2: Responses of Respondents on Plastic Waste Management Strategies in Enugu South L.G.A

S/N	Plastic Waste Management Strategies	SA		A		U		D		SD		Mean	Percent
		F	%	F	%	F	%	F	%	F	%		
1	Use of plastics should be banned	2	1.70	12	10.17	18	15.25	39	33.05	47	39.83	2.0085	40.1695
2	More environmental awareness creation should be carried out	44	37.23	39	33.05	21	17.80	14	11.86	0	0	3.9576	79.1525
3	Implementation and enforcement of polluters pay principle	26	22.03	38	32.20	23	19.49	21	17.80	10	8.48	3.4153	68.3051
4	Implementation of extended producers responsibility	22	18.64	46	38.98	25	21.19	23	19.49	2	1.70	3.5339	70.6780
5	Creation of plastic waste recycling centers	41	34.75	40	33.90	17	14.41	20	16.95	0	0	3.8644	77.2881
6	Introduction of purchase discount for using reusable plastic products	24	20.34	57	48.31	18	15.25	17	14.41	2	1.70	3.7119	74.2373
7	Increase in price of plastic products	20	16.95	30	25.42	32	27.12	14	11.86	22	18.64	3.1017	62.0339
8	Involvement of stakeholders/citizens in plastic waste management policy making	31	26.27	53	44.92	16	13.56	13	11.02	5	4.24	3.7797	75.5932
9	Development of effective policies on plastic waste	30	25.42	56	47.46	19	16.10	13	11.02	0	0	3.8729	77.4576
10	Introduction of incentives for plastic reuse	5	4.24	19	16.10	36	30.51	37	31.36	21	17.80	2.5763	51.5254
11	Introduction of incentives for plastic recycling	16	13.56	19	16.10	34	28.81	31	26.27	18	15.25	2.8644	57.2881
12	Introduction of plastic tax	0	0	17	14.41	8	6.78	49	41.53	44	37.29	1.9831	39.6610
13	Effective monitoring of policies on plastics	24	20.34	51	43.22	18	15.25	24	20.34	1	0.85	3.6186	72.3729
14	Introduction of plastic charges to customers	25	21.19	38	32.20	12	10.17	36	30.51	7	5.93	3.3220	66.4407
Cluster Mean and Percent												3.2579	65.1574

3.3 Plastic waste management strategies in Enugu East L.G.A

Table 3 summarizes the responses of respondents in Enugu East L.G.A on plastic waste management strategies. The percent statistics of the weighted mean shows that the suggested plastic waste management strategies include: more environmental awareness creation should be carried out (86.1539%), implementation and enforcement of polluters pay principle (74.1026%), creation of plastic waste recycling centers (83.718%), introduction of purchase discount for using reusable plastic products (70.3846%0, development of effective policies on plastic waste (80.1282%), introduction of incentives for plastic recycling (76.9231%), and effective monitoring of policies on plastics (79.2308%).

Table 3: Responses of Respondents on Plastic Waste Management Strategies in Enugu East L.G.A

S/N	Plastic Waste Management Strategies	SA		A		U		D		SD		Mean	Percent
		F	%	F	%	F	%	F	%	F	%		
1	Use of plastics should be banned	48	30.77	12	7.69	27	17.31	39	25	30	19.23	3.0577	61.1539
2	More environmental awareness creation should be carried out	68	43.59	77	49.36	5	3.21	3	1.92	3	1.92	4.3077	86.1539
3	Implementation and enforcement of polluters pay principle	55	35.26	38	24.36	38	24.36	12	7.69	13	8.33	3.7051	74.1026
4	Implementation of extended producers responsibility	26	16.67	51	32.69	48	30.77	23	14.74	8	5.13	3.4103	68.2051
5	Creation of plastic waste recycling centers	77	49.36	48	30.77	19	12.18	9	5.77	1	0.64	4.1859	83.718
6	Introduction of purchase discount for using reusable plastic products	36	23.08	45	28.85	47	30.13	20	12.82	8	5.13	3.5192	70.3846

7	Increase in price of plastic products	27	17.31	34	21.8	29	18.59	49	31.41	17	10.90	3.0321	60.6410
8	Involvement of stakeholders/citizens in plastic waste management policy making	33	21.15	45	28.85	43	27.56	27	17.31	8	5.13	3.4359	68.718
9	Development of effective policies on plastic waste	50	32.05	70	44.87	25	16.03	9	5.77	2	1.28	4.0064	80.1282
10	Introduction of incentives for plastic reuse	23	14.74	33	21.15	53	33.97	32	20.51	15	9.62	3.109	62.1795
11	Introduction of incentives for plastic recycling	46	29.49	60	38.46	34	21.80	12	7.69	4	2.56	3.8461	76.9231
12	Introduction of plastic tax	21	13.46	33	21.15	30	19.23	46	29.49	26	16.67	2.8526	57.0513
13	Effective monitoring of policies on plastics	56	35.90	56	35.90	26	16.67	18	11.54	0	0	3.9615	79.2308
14	Introduction of plastic charges to customers	13	8.33	26	16.67	32	20.51	49	31.41	36	23.08	2.5577	51.1539
Cluster Mean												3.4991	69.9817

3.4 Plastic waste management strategies suggested by staff of ESWAMA

Table 4 summarizes the responses of respondents from Enugu State Waste Management Authority (ESWAMA) on plastic waste management strategies. The percent statistics of the weighted mean shows that the suggested plastic waste management strategies include: more environmental awareness creation should be carried out (83.2%), implementation and enforcement of polluters pay principle% (76), implementation of extended producers responsibility (75.2%), creation of plastic waste recycling centers (86%), involvement of stakeholders/citizens in plastic waste management policy making (86.8%), development of effective policies on plastic waste (86%), introduction of incentives for plastic reuse (73.6%), introduction of incentives for plastic recycling (78%), effective monitoring of policies on plastics (80%).

Table 4: Responses of ESWAMA staff on Plastic Waste Management Strategies

S/N	Plastic Waste Management Strategies	SA		A		U		D		SD		MEAN	PERCENT
		F	%	F	%	F	%	F	%	F	%		
1	Use of plastics should be banned	10	20	10	20	7	14	14	28	9	18	2.96	59.2
2	More environmental awareness creation should be carried out	23	46	20	40	1	2	4	8	2	4	4.16	83.2
3	Implementation and enforcement of polluters pay principle	11	22	24	48	9	18	6	12	0	0	3.8	76
4	Implementation of extended producers responsibility	13	26	22	44	8	16	4	8	3	6	3.76	75.2
5	Creation of plastic waste recycling centers	25	50	18	36	4	8	3	6	0	0	4.3	86
6	Introduction of purchase discount for using reusable plastic products	10	20	19	38	8	16	10	20	3	6	3.46	69.2
7	Increase in price of plastic products	4	8	8	16	10	20	21	42	7	14	2.62	52.4
8	Involvement of stakeholders/citizens in plastic waste management policy making	25	50	19	38	4	8	2	4	0	0	4.34	86.8
9	Development of effective policies on plastic waste	24	48	21	42	2	4	2	4	1	2	4.3	86
10	Introduction of incentives for plastic reuse	12	24	21	42	7	14	9	18	1	2	3.68	73.6
11	Introduction of incentives for plastic recycling	13	26	26	52	5	10	5	10	1	2	3.9	78
12	Introduction of plastic tax	5	10	9	18	10	20	18	36	8	16	2.7	54
13	Effective monitoring of policies on plastics	22	44	15	30	5	10	7	14	1	2	4	80
14	Introduction of plastic charges to customers	12	24	10	20	2	4	16	32	10	20	2.96	59.2
Cluster Mean and Percent												3.6386	72.7714

From tables 1, 2, 3, to effectively manage plastic waste in the area, the following strategies were suggested by the public: more environmental awareness creation should be carried out; implementation and enforcement of polluters pay principle; creation of plastic waste recycling centers; introduction of purchase discount for using reusable plastic products; involvement of stakeholders/citizens in plastic waste management policy making; introduction of incentives for plastic reuse; development of effective policies on plastic waste; introduction of incentives for plastic recycling; and effective monitoring of policies on plastics. These agree with the findings in Kevin (2018); Kate (2011); Ndinwa and Peretomode (2014); Ogwo, *et al* (2013), *Vorapot, et al* (2016), Heng, *et al* (2008) as strategies for plastic waste management. They also agree with the responses from the staff of Enugu State Waste Management Authority (ESWAMA) (Table 4) which reveals that plastic waste management strategies in Enugu Metropolis should include: creation of more environmental awareness, implementation and enforcement of polluters pay principle, implementation of extended producers responsibility, creation of plastic waste recycling centers, involvement of stakeholders/citizens in plastic waste management policy making, development of effective policies on plastic waste, introduction of incentives for plastic reuse, introduction of incentives for plastic recycling, effective monitoring of policies on plastics. These suggestions were used in designing a framework for plastic waste management in the state.

3.5 Framework for Plastic Waste Management

A framework for plastic waste management was developed as shown in Figure 1. For the sake of clarity the framework is called 3P's. Effective plastic waste management can be achieved through implementing the 3Ps as noted below:

- **P**olicy formulation
- **P**olitical will and enforcement
- **P**utting up a working infrastructure for plastic waste management

That is:

Policy formulation **+ P**olitical will and Enforcement **+ P**utting up a working infrastructure for plastic waste management **=** Effective plastic waste management

The plastic waste management strategies under each of these Ps are listed as shown below, and subsequently used in the design of framework.

1. *Policy formulation*
   - Effective policies on plastic waste management should be formulated by the state house of assembly.
   - Stakeholders/citizens should be involved in plastic waste management policy making
2. *Political will and enforcement*
   - The government must be determined and committed to formulating, implementing and enforcing policies on effective plastic waste management. This must first of all start with the acknowledgment by the government, the huge environmental nuisance caused by the increased plastic waste generation in the state.
   - Implementation and enforcement of Extended Producers Responsibility(EPR) such that producers take responsibility for the waste generated from the use of their plastic products
   - Implementation and enforcement of Polluters Pay Principle (PPP) such that any individual that indiscriminately disposes of plastic waste should be fined.
3. *Putting up a working infrastructure for plastic waste management*
   - Plastic waste recycling centers should be created in strategic locations within the state.
   - More environmental awareness on the impact of plastic waste on the environment and human health should be created by the government and stakeholders through the media.

The 3Ps are embedded in the 3 external triangles as shown in figure 1. Some of the strategies as suggested by the respondents that should be implemented in achieving effective plastic waste management fall in-between two Ps. To this effect, these strategies are sandwiched in-between the two Ps they fall in, hence, these strategies are found in-between two triangles. They include the following:

- Effective monitoring of policies on plastics waste management
- Incentives for plastic reuse should be introduced in retail shops to encourage consumers on plastic reuse.
- Incentives for plastic recycling should be introduced to encourage plastic recycling by individuals and informal plastic waste recyclers.
- Introduction of purchase discount for using reusable plastic products

All these Ps are interconnected of which a failure in one could bring about a failure in the effective plastic waste management. However, to avoid such failure, it is imperative to put into consideration the components of these 3 Ps.

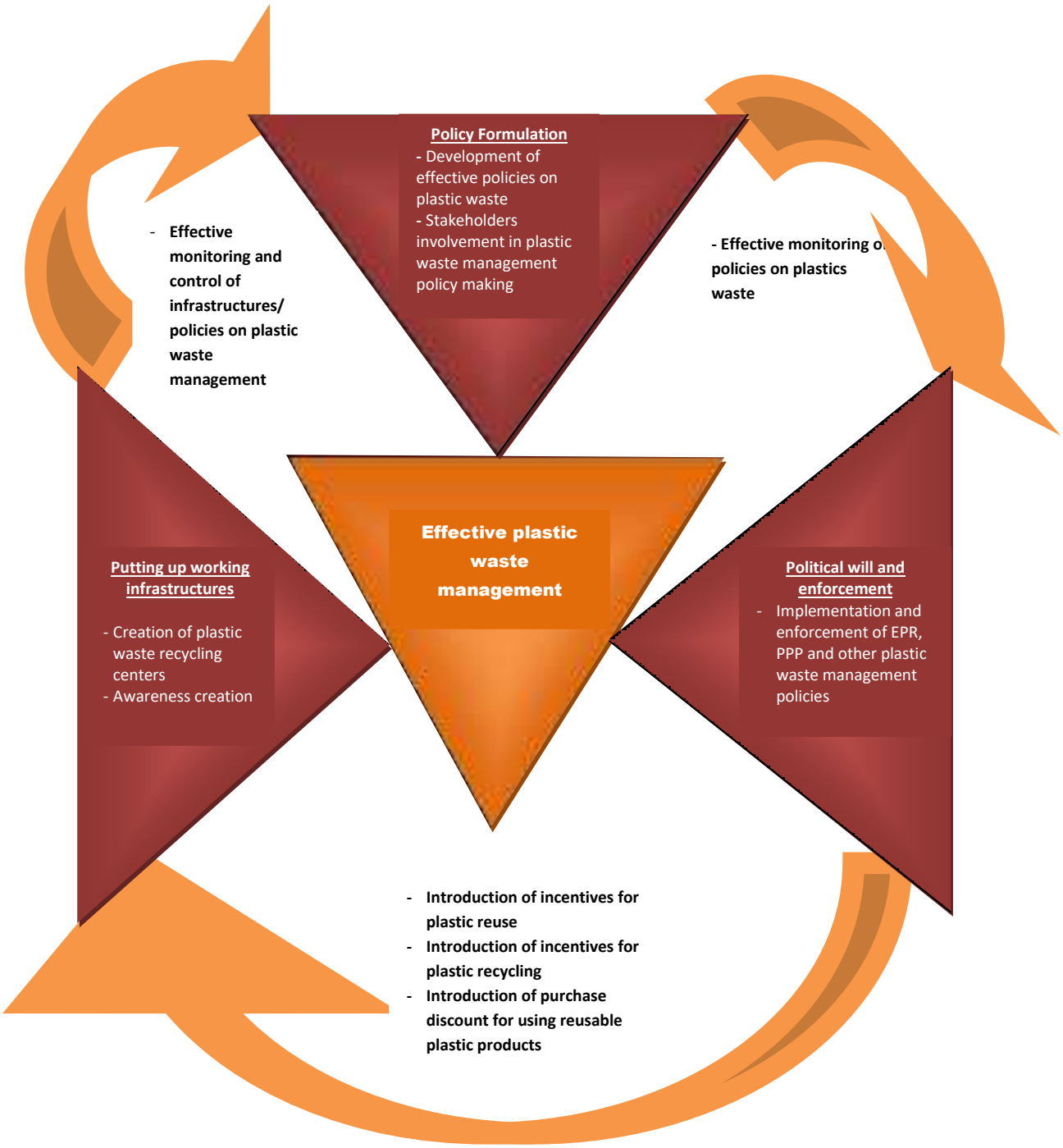

Figure 5.17 Framework for effective plastic waste management

The study revealed that plastic waste management strategies in Enugu Metropolis should include: creation of more environmental awareness, implementation and enforcement of polluters pay principle, implementation of extended producers responsibility, creation of plastic waste recycling centers, involvement of stakeholders/citizens in plastic waste management policy making, development of effective policies on plastic waste, introduction of incentives for plastic reuse, introduction of incentives for plastic recycling, effective monitoring of policies on plastics. These strategies were used to design a framework for plastic waste management in Enugu state to assist the government and Non-Governmental Organizations (NGOs) in plastic waste management considering the ubiquitous state of plastic waste in Enugu

Metropolis. It was therefore recommended that the developed framework for plastic waste management from this study be reviewed and implemented to address the challenges of plastic waste in Enugu metropolis.

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