

Improving Public Health and Environment through Plastic Waste Management in Mumbai Metropolitan Region

Sanjay RODE¹

Abstract

The Mumbai Metropolitan Region is growing in terms of population, industry, educational and commercial units. The daily requirements of commodities and services by all units have increased fast. Plastic is used extensively for packing, protection and service of various commodities. The use of plastic is much higher by industry and households in region. In Brihan Mumbai Municipal Corporation, the density of population is higher. The concentration of small and large industries is more. Therefore the plastic use is much higher for different purposes. It leads to more waste of plastic. In Ulhasnagar Municipal Corporation, the population and industrial units are less. Therefore plastic waste is less generated. Theaters are generating less plastic waste in metropolitan region. The Brihan Mumbai Municipal Corporation (BMC) and municipal corporations in Thane district will continuously generate more plastic waste in future. The Tobit regression model shows that plastic waste is positively co-related and statistically significant with pollution and industry in region. Therefore the comprehensive policies are required to reduce plastic waste. This is because plastic waste is affecting on the health of human being. It also affects negatively on soil, air and water. The entire food supply chain gets affected due to plastic waste. The water logging is common due to plastic waste in region. It chock ups the drainage system and it becomes the ground for mosquitoes. It further leads to dengue, malaria and other diseases in region. Municipal corporations must collect plastic in separate bins and process it. The plastic and e-waste can be utilized for road construction in region. All the policies will certainly help to reduce the plastic waste and maintain the clean environment in region.

Key words: *Health care, Institutions, Impact, Quality.*

JEL classification: *I15, P46, Q53.*

INTRODUCTION

The use of plastic is increasing exponentially due to tremendous growth in population, urbanization and changed life style (Gawande, 2013). The plastics are widely used in many important day to day applications such as clothing, household appliances and automotive products and aerospace (Sarker et.al, 2012). The plastic use has increased and therefore an explosive growth of the plastic industry took place in the last few decades.

The use of the plastic is much higher in day to day life of people in Mumbai Metropolitan Region. The industry use plastic for packing, protecting and serving all kinds of consumer

¹ Ph.D, Assistant professor, Department of Economics, S.K.Somaiya College, Mumbai University, Mumbai, India, Email: Sanjayjrode@gmail.com.

and electronic goods. The household members start their daily activities with plastic. The tooth brush, tooth paste, soaps are used at morning, which are packed in plastic. Households buy milk, vegetables and commodities from retail shops and it is carried in plastic bags. Finally, the waste plastic bags are thrown in bins. During illness of family members, the medicines are purchased from medical shops. The medicines are packed in plastic bottles and packets. The saline, tablets, injections are covered up of plastic and it is used extensively in medicines. During illness maximum plastic waste is generated. Almost all the fruits juices, mineral water is packed in plastic bottles. The chocolates, fast food packets create maximum plastic waste. All the goods are daily purchased by the household members in region. After its use, the plastic is thrown in bins.

Households buy different electronic appliances such as refrigerator, radio, computer, laptop, air conditioner, television, mobiles. They are made up of plastic and after their damage; the old items are thrown in dust bins. There is no proper e-waste management in region. The population is continuously using various electronic and plastic items. The household members use debit, credit, business cards. The expired cards are thrown in dustbins. In Mumbai city, people visit regularly to malls and super markets. They buy day today requirements and commodities from malls and super markets at discount prices. The maximum plastic waste is generated during such visits and purchase. People in region are visiting different theaters to watch movies. During interval they eat packed food, drink tea, coffee and buy bottled water. At the interval, they also eat popcorns, fast food, chocolates and other packed food. It generates maximum plastic waste. The theaters run shows thrice in a day and the maximum generated plastic is thrown in bins. Many people visit malls in region. They have soft drinks, bottled water, tea, coffee in malls. They shop different commodities regularly. For delivering goods, plastic bags are used. Maximum plastic bags are used in packing of goods. Such activities generate maximum plastic waste in region. School children and youths also generate plastic waste. They buy chocolates, packed food, corn, biscuits. They are covered of plastic packets. The maximum plastic waste is generated when such items are purchased and consumed. The children and youths also buy note books, books, pen and other materials from stationary shops. But such activities and requirements also generate maximum plastic waste. In regular school and college days, children and youths carry water in plastic bottles. All the children and youths activities generate maximum plastic waste in region.

Industrial units generate plastic and related waste. Industries are using plastic for packing and delivery of different products. Some industries produce plastic bags, drums, water tanks, plastic pipes. They generate maximum plastic waste during delivery of products. The restaurant and hotels daily buy different kinds of vegetables and fruits from market. They use plastic bags for delivery of different food orders. The bottled water, dishes, cups of tea and coffee are used to serve food. Such consumed and used products generate maximum plastic waste. Hospitals, community centers, health centers treat various patients. They use tablets, syringes and other medicines. Some medicines are bought from medical shops. Such used medicines generate more plastic waste in region. Patients want early recovery therefore more medicines are used. The plastic waste is generated during shopping. All shops use plastic bags for packing of garment, food items, watches and electronic products. The plastic waste is continuously increasing with increase in urbanization in Mumbai Metropolitan Region. The use of plastic leads to widespread littering of plastic in the region. This is because no proper collection and management exists of plastic. The uncollected and unprocessed plastic waste remains in environment for several years. The

underground and open plastic pollutes soil and water (Chavan, 2013). It is affecting on human health and it can lead to cancer and reproductive problem among women. Unprocessed plastic also adversely affects on birds reproductive and digestion system. The plastic products flow to Arabian Sea and they become plastic debris. Such debris in Arabian Sea is responsible for deaths of fishes, birds and marine mammals. The marine animals get caught in plastic debris. They untangle themselves and they die after suffocating. Seabirds often mistake trash floating on the ocean's surface. They often die after eating such plastic waste. This is because such plastic obstruct and physically damage a sea birds digestive system. The reduced digestive ability leads to malnutrition, starvation and deaths. The plastic nets at Arabian Sea beds cause damage to coral reef. In Mumbai Metropolitan Region, the plastic waste is not collected on regular basis. It flows with water and air. It gets hit and broken down in pieces. In such process, the methane is released in environment. Such gas adversely affects human, birds and animals. The uncollected plastic waste causes flooding in region because it chock ups the drainage system. The flooding in region causes deaths of many people and damage of property. It also leads to malaria, dengue and other diseases. The plastic waste is affecting directly and indirectly to all lives in region.

The main objective of this paper is to study the plastic waste and its types in region. The municipal corporations generate more plastic waste but it is not collected and processed. It is ultimately affecting on the human, animals and marine resources. The first part of the research paper deals with definition of plastic waste and its types. The second part of paper deals with data collection and methodology of plastic waste in region. The third part of paper explains about plastic waste in Municipal Corporations in region. The second last part of paper deals with regression results. The last part of paper deals with policy implication and conclusion.

2. DATA

We have collected secondary data of population from census 2001 and 2011. Such data gives the detail population in all Municipal Corporations. The city development report of Mumbai, Thane, Navi-Mumbai, Ulhasnagar, Bhiwandi-Nizampur, Kalyan-Dombivali and Mira-Bhayander Municipal Corporation provides number of units of hospitals, hotels, theaters, commercial establishments and academic institutions. We have classified data according to different years and calculated the growth rate of population and other units. The stata@12 software is used to understand the correlation of plastic waste with different types of units of all corporations in region. We have also calculated the growth of plastic waste in each municipal corporation over the period of time in Mumbai Metropolitan Region.

2.1 Methodology

We have calculated the plastic waste according to the following formula. It is shown as follows.

$$Pw = ((100 * Pw) / Sw) \quad (1)$$

It means plastic waste is some proportion of solid waste in Municipal Corporations in region.

Alternatively,

$$PW = PC_{pw} * Nu \quad (2)$$

Plastic waste is equal to the per capita plastic waste by number of units. Such units are households, academic institutions, industry, theaters, commercial establishments, hospitals, hotels and welfare institutions. Therefore based on above two formulas, we have calculated plastic waste in Mumbai Metropolitan Region.

2.2 Statistical model

We have developed the statistical model of plastic waste in metropolitan region.

$$P_w = (MC) \quad (3)$$

The plastic waste is calculated for Municipal Corporations in Mumbai Metropolitan Region.

$$\text{MC} = (Mu, T, NM, BN, KD, U, MB) \quad (4)$$

The municipal corporations in Mumbai Metropolitan region consist of Municipal Corporation of Greater Mumbai, Thane Municipal Corporation, Kalyan Dombivali Municipal Corporation, Ulhasnagar Municipal Corporation, Navi Mumbai Municipal Corporation, Mira Bhayander Municipal Corporation, Bhiwandi Nizampur Municipal Corporation. The plastic waste generated by different types of units in region. It is further classified as follows.

$$\text{PW}_{mc} = (H, A, I, T, C, Hs, Ht, W) \quad (5)$$

The plastic waste in municipal corporations consists of households, academic institutions, industry, theaters, commercial establishments, hospitals, hotels and welfare institutions. It is measured in terms of metric tons for a day in each municipal corporation.

3. DEFINITION OF PLASTIC

The word plastic is defined by many research scholars in literature. The plastic word is derived from the Greek word "plastikos". The meaning is capable of being shaped or molded. After industrial revolution in the 1930s, it is called as polyamide. It is better known as nylon. Nylon was the first purely synthetic fiber introduced by Du Pont Corporation. It is introduced at the 1939 World's fair in New York City. Pure plastic have low toxicity due to their insolubility in water. They are bio-chemically neutral. Plastic is only affected by heat. Its shape changes when it is heated with high temperature.

The plastic products are used in an enormous and wide range in day today life. It is due to low manufacturing cost, easy to manufacture and it is not affected to water. The plastic has replaced traditional materials like wood, stone, horn, bone, leather, paper, metal, glass and ceramic in many fields. Plastic is used in preparing, plumbing, toys, furniture, packing, making of containers, spare-parts of different machines, interiors etc. In India, nearly forty

two percent plastic is used by packaging industries (Lodha & Sheikh, 2014). The use of plastic for different purposes is increasing fast.

3.1 Types of plastic

In literature, plastic is divided into various types. But plastics are mainly classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes and halogenated plastics. Plastics are classified by the chemical process used in their synthesis, such as condensation, polyaddition, and cross linking. There are two types of plastics and they are thermoplastics and thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and it can be molded again and again. They include polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetra fluoroethylene. In the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is a thermosetting process. Before heating with sulfur, the polyisoprene is a tacky, slightly runny material, but after vulcanization the product is rigid and non-tacky. The properties of plastics are defined chiefly by the organic chemistry of the polymer. They are hardness, density, and resistance to heat, organic solvents, oxidation, and ionizing radiation (Chavan, 2013). Such types of plastic are used to manufacture different plastic as per use. There is commercialization in manufacturing of plastic and plastic related items.

4. PLASTIC WASTE IN MUMBAI CITY

Plastic is used by individuals, households, hospitals and commercial shops in region. We have estimated the plastic waste in Mumbai Metropolitan Region. It is estimated as per the municipal corporations in region.

Table 1. Plastic waste in Municipal Corporations of MMR

Municipal Corporation	Plastic waste(MT)	Percent
MCGM	795.33	65.14
TMC	95.52	7.82
KDMC	87.26	7.15
UMC	49.19	4.03
NMMC	86.01	7.04
MBMC	55.10	4.51
BNMC	52.47	4.29
Total	1220.88	100.00

Source: Computed from secondary data

The plastic waste is 795.33 MT in MCGM. In the Mumbai city, there are 31 plastic related industries in operation. All these industries are manufacturing the plastic items. In TMC, we have calculated the 95.52MT plastic waste in current year. The KDMC has 87.26 MT plastic waste. In UMC, 49.19 MT plastic waste is found. The population density is low in corporation. The industrial units are few and therefore plastic waste is low. In NMMC, we

have calculated the 86.01MT plastic waste. In MBMC, the plastic waste is 55.10MT in current period. The BNMC has 52.47 MT plastic wastes. Total 1220.88 MT plastic wastes have calculated in Municipal Corporations of Mumbai Metropolitan Region. It is calculated for current year that is 2015. Among all the municipal corporations, the Mumbai Corporation of Greater Mumbai has 65.14 percent of plastic waste in region. The UMC is generating the lowest plastic waste in region. It is only 4.03 percent of the total plastic waste in region. Such plastic waste does explain about its nature. Therefore there is need to calculate of the plastic waste according to type. Following table explains the type of plastic in Mumbai city.

Table 2. Plastic waste in Mumbai city

Type of plastic	Plastic waste (Metric Tons)	Percent
Households	505.35	63.54
Slums	128.07	16.10
Academic institutions	11.62	1.46
Industry	12.15	1.53
Theaters	3.33	0.42
shops and commercial establishments	108.99	13.70
Hospitals	7.47	0.94
Hotels	4.77	0.59
Welfare/recreation	13.59	1.70
Total	795.34	100.00

Source: Computed from secondary data

Above table shows that households generate 505.35 MT plastic waste in Mumbai city. In slums, 128.07 MT plastic waste is calculated. The households generate plastic waste as vegetable and milk plastic bags, old mugs, buckets, combs, paint brushes, soapboxes, detergent containers, cassette covers, tooth brush holders, molded dust bins and toys. Such plastic is regularly thrown in bust bins. From the academic institutions, we have calculated 11.62 MT plastic waste. The children and youths buy books, notebooks and other stationary from book stalls. Industry generates 12.15 MT plastic in Mumbai city. The plastic waste is created during packing of consumers, electronic and regular durable goods. The theaters could be generating 3.33 MT plastic waste. The shops and commercial establishments could be generating 108.99 MT plastic waste. It is 13.70 percent of the total plastic waste. In city, the number of shops and commercial units are increasing fast. Therefore the contribution of plastic waste is also higher. Hospitals could be generating 7.47 MT of plastic. It is only 0.94 percent of the total plastic waste. The plastic is generated during the treatment of patient and taking medicines. The hotels could be generating 4.77 MT plastic waste and it could be 0.59 percent of total plastic waste. Maximum plastic waste is generated at purchase and delivery of food. The welfare and recreation centers could be generating 13.59 MT plastic waste in city. Total waste in Mumbai city could be generated

as 795.34 MT in 2015. We have also estimated the plastic waste according to the types in Municipal Corporations of Thane district.

Table 3. Plastic waste according to types in Municipal corporations of Thane district (MT)

Types	Thane	Kalyan-Dombivali	Ulhasnagar	Navi-Mumbai	Mira-Bhayandar	Bhiwandi-Nizampur
Population	69.72 (72.99)	59.57 (68.27)	23.45 (47.68)	56.81 (66.06)	35.04 (63.59)	33.12 (63.13)
Industry	7.93 (8.30)	11.74 (13.45)	14.89 (30.28)	14.20 (16.52)	8.76 (15.90)	8.28 (15.78)
Shops	0.99 (1.04)	0.93 (1.06)	0.82 (1.66)	0.62 (0.73)	1.05 (1.90)	0.84 (1.59)
Hotels	3.59 (3.76)	3.05 (3.50)	2.68 (5.45)	2.38 (2.77)	2.37 (4.29)	2.18 (4.16)
Restaurants	1.96 (2.06)	2.14 (2.46)	2.28 (4.63)	2.27 (2.64)	2.57 (4.67)	1.92 (3.67)
Theaters	1.12 (1.17)	1.17 (1.34)	1.35 (2.75)	0.68 (0.79)	1.34 (2.43)	1.31 (2.50)
Primary schools	1.79 (1.88)	1.51 (1.73)	0.74 (1.50)	1.79 (2.08)	0.89 (1.62)	0.84 (1.60)
Secondary Schools	1.62 (1.70)	1.43 (1.64)	0.70 (1.41)	1.70 (1.97)	0.84 (1.53)	0.80 (1.52)
Colleges	0.23 (0.25)	0.14 (0.17)	0.07 (0.14)	0.17 (0.20)	0.08 (0.15)	0.08 (0.15)
Post graduate Institutions	0.21 (0.22)	0.15 (0.17)	0.07 (0.15)	0.18 (0.21)	0.09 (0.16)	0.08 (0.16)
Health	6.35 (6.64)	5.42 (6.21)	2.14 (4.36)	5.19 (6.04)	2.07 (3.76)	3.01 (5.74)
Total	95.52 (100.00)	87.26 (100.00)	49.19 (100.00)	86.01 (100.00)	55.10 (100.00)	52.47 (100.00)

Source: Computed from secondary data

In Thane city, the population could be generating 69.72MT plastic waste. In Ulhasnagar, 23.45 MT plastic could be generated in the city. In Ulhasnagar, industry could be generating 14.89 MT plastic waste. Industry could be generating only 7.93 MT plastic waste in Thane city. An industry generates the plastic waste as wire coating, electrical cable sheathing and telephone cable sheathing. The packaging bags, pouches, milk packing pouches, liners for HDPE woven sacks, grocery bags, garbage bags, bags for railway food packing, food packets, shopping bags, garment packing bag, inbox packing and electronic goods packaging are the few examples. In Mira-Bhayander, shops could be generating 1.05MT plastic waste. In terms of population, it is smallest Municipal Corporation. In the Bhiwandi-Nizampur Municipal Corporation, plastic waste could be generated as only 0.85MT every day. In Bhiwandi-Nizampur Municipal Corporation, the waste plastic is not collected regularly. In Ulhasnagar Municipal Corporation, the hotels could be generating

2.68MT plastic waste. The number of hotels could be generating waste during the delivery of food and purchase of the vegetables. The restaurants could be generating 2.57MT plastic waste in Mira Bhayander Municipal Corporation. It is observed lowest plastic waste in the Bhiwandi-Nizampur Municipal Corporation (1.92 MLD). The theaters could be generating 1.35MT plastic waste in Ulhasnagar Municipal Corporation. There are many mini and big theaters in city. But it is inversely related in Navi Mumbai Municipal Corporation. The numbers of theaters are less and therefore less plastic waste is generated. The density of population is low. The people go to Mumbai to watch movies. Therefore plastic waste is only 0.68MT in Navi Mumbai. The primary school could be generating 1.79MT plastic in Thane and Navi Mumbai Municipal Corporation. The children's population is high in these corporations. The number of educational institutions in Navi Mumbai and Thane are more. Therefore students and youths population generates the plastic waste. But it is inversely related in Ulhasnagar, where the numbers of youths are less and educational institutions are limited in number. It is observed lowest as 0.74MT in Ulhasnagar. The secondary schools could be generating 1.70MT plastic waste in Navi Mumbai. It is only 0.70MT in Ulhasnagar. The colleges could be generating 0.23MT plastic waste in Thane. It could be only 0.07MT in Ulhasnagar. The post graduate institutions could be generating 0.21MT plastic waste in Thane. The health care institutions could be generating 6.35MT plastic waste. It is only 2.07 MT plastic in Mira-Bhayander. The Thane Municipal Corporation is generating 95.52MT plastic waste every day. But the Ulhasnagar Municipal Corporation could be generating 49.19MT plastic waste. It means the plastic waste is more than double in Thane city as compare to Ulhasnagar city. The people and industries are the contributor of the maximum plastic waste. The readymade garment seals and tags, films for covering outdoor signboards, children toys, dolls, protective coating, external coating for pipes, machinery parts coating are used by people. There are number of examples of the plastic waste. The use of plastic itself creates maximum waste.

5. PLASTIC WASTE IN FUTURE

The plastic use will continuously increase in future. The population and other units will continuously grow in future. Therefore we have estimated the plastic waste for the future period. Such plastic waste is estimated for the Mumbai and Municipal corporations of Thane district. It is presented in the following figure.

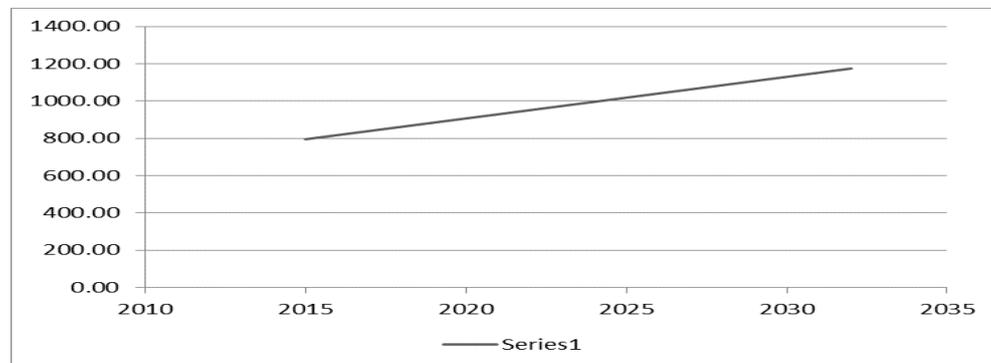


Figure 1 Plastic waste in Mumbai city (MT)

Source: Computed from secondary data

We have estimated the plastic waste in Mumbai city. The total plastic waste in city is estimated as 795MT in current period. In 2025, it could cross thousand metric tons limit. In 2032, the plastic waste could reach up to 1200 MT limit. It is huge plastic waste generated in the city. It is because of population, industrial units etc.

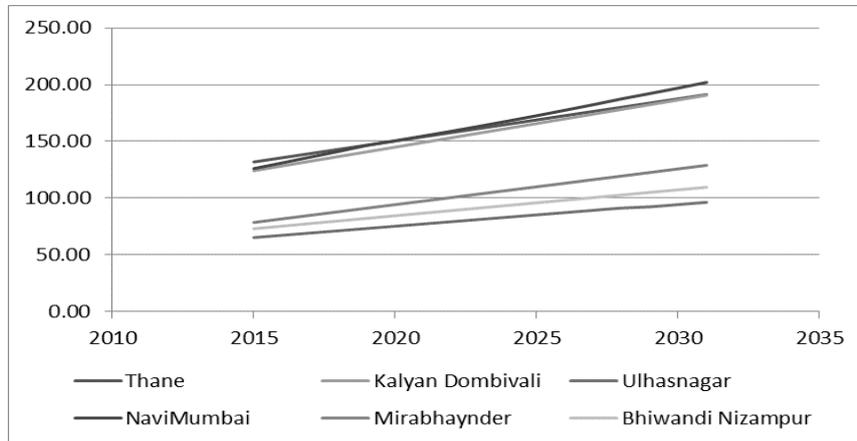


Figure 2. Plastic waste in Municipal Corporation of Thane district (MT)

Source: Computed from secondary data

We have estimated that the Mira Bhayander, Bhiwandi-Nizampur and Ulhasnagar Municipal Corporation have less than hundred metric tons of plastic waste till 2020. But during 2022, the plastic waste in Mira Bhayander will reach up to 100MT. In Bhiwandi-Nizampur Municipal Corporation, the plastic waste will reach hundred metric tons in 2026. In Ulhasnagar Municipal Corporation, the plastic waste will be hundred metric tons in 2032. In Thane, Navi Mumbai, Kalyan-Dombivali Municipal Corporation, the plastic waste will reach 150metric tons in 2020. In 2032, Thane Municipal Corporation will generate more than 200 metric tons of plastic waste. The growth of plastic waste in Thane Municipal Corporation is observed as highest in Thane district and as compare to other municipal corporations. The lowest growth of plastic waste is observed in the Ulhasnagar Municipal Corporation. In 2030, the plastic waste in UMC could be 100 MT. Such high plastic waste generation required the plastic waste processing and management. At present, the plastic is not processed and it either collected with sewage or it flow with water and air. It remains as it is for years in region and blocks the drainage system. It affects the health of the people and environment.

6. REGRESSION RESULT

We have used Tobit regression model (Greene, 2003) to find the co-relation between dependent variable and different independent variables. The plastic waste by municipal corporations is because of population density, slums, industrial units and commercial establishments. The Tobit model is suitable because of sum of plastic waste in municipal corporations in Mumbai Metropolitan Region. The quantity of plastic in each municipal corporation is a mixture of discrete and continuous figure. The other regression model shows the multi-co linearity problem. Therefore Tobit model helps to identify significant plastic waste by domestic, industrial and commercial units.

$$Y_i^* = \beta X_1 + \beta X_2 + \dots + \beta X_n + \varepsilon_i \text{ Where } Y_i^* > 0 \quad (6)$$

The ordinary least squares estimates are smaller in absolute value than the maximum likelihood estimates. The regression results are presented in the following table.

Table 4. Regression results of the plastic waste in Mumbai Metropolitan Region

Variables	Co-efficient	Standard error	T test	95 % conf. interval
Population	0.74**	0.38	1.94	1.56-0.07
Industry	8.00*	1.10	7.22	5.64-10.36
Constant	1186.35	374.98	3.16	387.08-1985.61
	LR Chi ² =211.91	Prob>Chi ² =0.00	Log likelihood=-28.169	PseudoR ² =0.790

* significant at 1 percent ** significant at 5 percent

Source: Computed from secondary data

The plastic waste in all the municipal corporations is positively co-related to the population. Population use plastic for different purposes. It is used for carrying various commodities, cloths, fruits and vegetables etc. The plastic waste is positively co-related to industry. Household- furniture, grocery bags, corrugated tubes and pipes, mugs, soap boxes, tent covers, tarpaulins, chairs, fridge bottles, containers, drinking water glasses, buckets, water tanks, mosquito nets, waste boxes, dust bins, luggage, ice-trays and squeezable bottles. Many small and large industries are using the plastic waste for different purposes. They use plastic for packaging, delivering of goods and buy various inputs. It is used for fuel tanks, decorative covers on car wheels, water tanks, petrol cans, caps, plugs, bumpers, boats, mini truck cabs etc. The drainage pipes, construction pipe, joints pipes, hoppers and shutters for buildings are made up of plastic only. The other examples of plastic products as telephone wires, television cables, dairy foods, bottle caps, bottles for food packaging, bottle for pesticides, water packaging containers, cement packing, jumbo bags for export packaging, flower packing etc. The use of plastic itself generates more waste in region.

7. POLICY IMPLICATION AND CONCLUSION

The use of plastic for different purposes is increasing fast. The population growth, industrialization, consumerism and technological development have been responsible for tremendous increase in the rate of production of plastic waste (Poweth et al., 2013). The plastic waste generation is higher in Mumbai city. The growth of plastic is also observed higher in Municipal Corporations of Thane district. The population and industry generate more plastic waste in region. The people buy different commodities and they are packed in plastic. Industry produces plastic and pack commodities in plastic. Some industries produce all kinds of plastic products which are cheaper and good to use. Finally the plastic products are thrown in dustbins. Municipal corporations in region do not have facilities to segregate plastic at household level. It is not processed in region. The plastic waste is adversely affecting on health of people soil, air, fish, micro-organisms and seabirds. The plastic is not collected properly and it is finally flow with rainwater. Plastic blocks the drainage and sewerage system in corporation area. It leads to bad smells of water and the drainage water becomes the favorable spots of mosquitoes and other vectors. They spread large number of diseases such as encephalitis, dengue, fever and malaria in region. Many people die due to such diseases in region. There are number of alternative policies required to reduce plastic

waste in region. People must be taught about the use and segregation of plastic at household level. Mass media must educate people to segregate plastic and explain the ill effects of plastic. Municipal corporations must make the strict laws about use of plastic in day today life. It must take strict action against people who are responsible for plastic littering in region. Government must prepare audio and video programs of plastic segregation and use and it must run on television and radio. It will help to change behavior and attitude of people towards plastic use. It will reduce the use of plastic bags and promote alternative uses of plastic. There are number of alternatives available to plastic bags such as paper, green, degradable bags. The NGO's, academicians, planners and political parties should come forward and explain the alternative uses to plastic. They must use three environmental R's. They are as reduce, recycle and reuse plastic. Households must be encouraged to reduce plastic bags and bottles as many times as possible. It will curtail the production and use of plastic. For example plastic bottles can be reused as water bottles and milk containers. Municipal Corporation must encourage super markets and malls to reduce the use of plastic bags. There is mindset of people to accept more and more plastic bags at the point of sale in malls and super markets. People must be encouraged to bring their own cloth bags for shopping. Many countries have passed legislation to ban on plastic use, production and distribution (Adane & Diria, 2011). But in Mumbai Metropolitan Region, there are no restrictions on use of plastic products. There have been very limited studies in India on plastic in concrete (Ramadevi & Manju, 2012). Many roads agencies have been experience the problem of premature failure of pavements like potholes, roughness and cracks. It leads to poor performance of roads and its life. At the same time, there is steady increase in high traffic intensity in terms of commercial vehicles, increase in over loading of trucks and the significant variation in over loading of tracks and the significant variation in daily and seasonal temperature. The roads need to improve with engineering properties. The waste like plastic bottles, polymers, cups can be reused by powdering or blending it with crusher and it can be coated over aggregate and bitumen by any heating process (Patel et al., 2014). The rubber, bottle, electronic waste like keyboards, mouse, mother boards, mobile phones, tiers can be used by making powder or blending it with crushers. It can be mixed with the concrete process (Kandasamy & Murugesan, 2011). If the e-waste can be suitably utilized in highways road construction in region then the pollution and disposal problem of plastic can be reduced partly. If such material is tested and used in road making then it will help to reduce the corporation's yearly money expenditure on roads. The possible use of these materials should be developed for construction of low volume roads in different parts of region (Gawatre et al., 2015). All these policies will certainly help to reduce the use of plastic in region. At the same time, the waste plastic can be used for different purposes. All the policies will also help to make the clean environment and good public health in region. It will further promote economic growth of metropolitan region.

ACKNOWLEDEMENT

Author would like to thank to Mr. Rajendra Ichale for helpful comments and suggestions for this research paper.

REFERENCES

- Adane, L., & Diriba, M. (2011). Survey on the usage of plastic bags, their disposal and adverse impacts on environment: A case study in Jimma City, Southwestern Ethiopia. *Journal of Toxicology and Environmental Health Sciences*, 3(8), 234-248.
- Chavan, A. (2013). Use of plastic waste in flexible pavements. *International Journal of Application or Innovation in Engineering and Management*, 2(4):540-544.
- Gawande, A. (2013). Economics and viability of plastic road: A review. *J. Curr. Chem. Pharm. Sc.*, 3(4), 231-242
- Gawatre, D., Damal, V., Londhe S., Mane, A., and Ghawate, H. (2015). Environmental issues of plastic waste use in concrete. *International Journal of Innovative Research in Advanced Engineering*, 2(5), 114-118.
- Greene, W. (2003). *Econometric Analysis*. Fifth edition, Pearson Education Private Ltd, Indian Branch, Delhi, India.
- Kandasamy, R., & Murugesan, R. (2011). Fiber reinforced concrete using domestic waste plastics as fibers. *ARPN Journal of Engineering and Applied Sciences*, 6(3), 75-82.
- Lodha, G., & Sheikh, M. (2014). Plastic pollution in cities of Mumbai and Thane. *International Multidisciplinary Research Journal*, 1(4), 14-20.
- Patel, V., Popli, S., & Bhatt, D. (2014). Utilization of plastic waste in construction of roads. *International Journal of Scientific Research*, 3(4), 161-163.
- Poweth, M., George, S., & Paul, J. (2013). Study on use of plastic waste in road construction. *International Journal of Innovative Research in Science, Engineering and Technology*, 2(3):633-38.
- Ramadevi, K., & Manju, R. (2012). Experimental investigation on the properties of concrete with plastic PET (Bottle) fibers as fine aggregates. *International Journal of Emerging Technology and Advanced Engineering*, 2(6), 42-46.
- Sarker, M., Rashid, M., Rahman, S., & Molla, M. (2012). Environmentally harmful low density waste plastic conversion into Kerosene grade fuel. *International Journal of Energy and Environment*, 3(6), 871-880.