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Author(s): Sanjay RODE

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E-WASTE MANAGEMENT IN MUMBAI METROPOLITAN REGION: CONSTRAINTS AND OPPORTUNITIES

Sanjay RODE

University of Mumbai, Mumbai, India

sanjayrode@gmail.com

Abstract

The use of electronic goods is growing fast because of innovations, low price and easy to use facilities. Due to higher income, standard of living and professional requirement, people are replacing the electronic goods very fast. Mumbai Municipal Corporation is generating high e-waste in Mumbai Metropolitan Region. In Thane district, Thane Municipal Corporation generates high e-waste but Ulhasnagar Municipal Corporation generates low e-waste. E-waste generation is depending on population, health and education institutions, shops and malls, industrial units etc. E-waste in Municipal Corporations of Metropolitan Region is positively co-related to population growth. People are using different kinds of electronic products in their routine life. The old electronic products are discarded in bins. The market for replacement of electronic products is not well developed. The recycling facility is not well developed in region. The policy of awareness of e-waste to manufacturers, consumers, business houses will bring good result. Similarly buy back and exchange of electronic goods will reduce e-waste at certain extent in region. Municipal Corporations should provide collection, transportation, treatment, storage and disposal service of e-waste. Municipal Corporations should set the goal of e-waste free city. Such policies will help to reduce e-waste.

Keywords: Urbanization, recycling, pollution.

1. INTRODUCTION

Electronic industry is one of the fastest growing manufacturing industry in India (Kumar et.al, 2011). The new electric and electronic equipments have infiltrates all aspects of our daily life providing us with more comfort, health and security (Priyadarshini and Meenambal, 2011). The technological boom has also given different opportunities to human being. Therefore trade, commerce, education, health, welfare institutions and households are using the electronic goods for different purposes. As the electronic goods have more reasonably priced, the volume of electronics in society has increased exponentially. It is because large section of society is purchasing and using electronic goods. As the affordability has increased, the replacement rate with the speed of technology has also increased. Innovations offer more functionalities, smaller size and newer design in the market. Given the time lag between the purchase of the product and its end of life means that products purchased one to ten years ago are being discarded now. Most of the products are either out of service or new features are added in it. The old products and features are no more useful in surrounding environment. The old products are either

discarded or they are replaced by people. But the replacement system of old electronic products is not well functional in markets.

Maharashtra state is number one in e-waste production in India. Mumbai city is a financial and cultural capital of India. It generates more employment opportunities and attracts skilled labor force across the country. Due to high density of population, skilled labor force and technological innovations, electronic waste is growing fast in city. According to Central pollution control board (CPCB), Mumbai is at top in order to generate e-waste in the country. The Mumbai metropolitan region will generate 2.92 lakh ton e-wastes in 2020. It means e-waste is continuously rising with alarming rate in region.

At present, e-waste disposal is mixed with solid waste. It is posing a greater threat for environmental degradation and the effects are much more than they are estimated. E-waste that is land filled pollutes water, soil and air. E-waste contaminates rivers, wells and other water resources in the region. The air gets pollute due to emission of gases and burning of e-waste. The fertility of land declines due to e-waste landfill. Effects of e-waste on human health are widely observed. E-waste of chemicals such as lead, mercury, copper found in computer screens and televisions are poisonous. It can lead to fatal diseases like cancer, kidney failure, thyroid, hormone disruption and damage.

Most of the informal units are responsible for e-waste collection, segregation and disposal. Nearly 95 percent of the e-waste in region is processed by the informal sector. Women and children are collecting the e-waste in the metropolitan region. Women and children are less educated and they do not have much knowledge of e-waste. They collect e-waste and sell it to the retailer. In replace of that, they get few amount of money which is used for daily livelihood. Waste pickers are from poorer section of society therefore they can afford to work at lower wage. They do not get any medical allowance or compensation for injury. They are also not aware of such rights. They do not prefer to wear masks and hand gloves while handling e-waste. They are at high health risk due to exposure to dangerous and slow poisoning chemicals. But lower labor cost, high unemployment rate, migration and lack of protest are the reasons of the waste pickers working for e-waste collection.

E-waste management depends on the attitude of citizens. But lack of awareness among city residents is the major hurdle to keep e-waste management system in order (Ciocoiu et all, 2011). Consumers can affect the e-waste through environment friendly products, maintenance and environment conscious operation of products and careful disposal. The supplies of the product can affect the e-waste generation through offering environment friendly materials and components. The manufacturers can reduce the life cycle environment impacts of their products through influence. It can be done through product design, material choice, manufacturing process, product delivery and product system support.

But the efforts in awareness, manufacturing, segregation of e-waste and disposal are very low. E-waste is usually regarded as a waste problem which can cause environmental damage if not dealt with in an appropriate way. However the enormous resource impact of electrical and electronic equipment is widely overlooked. The electronic and electrical devices lead not only to significant environmental problems but also to systematic depletion of the resource base in secondary material (Schluep M. et.al 2009). Therefore e-waste needs to manage from manufacturing to recycling.

1.1. Definition of e-waste

There are different definitions are given for the e-waste by different authors and organizations. But the most common definition of e-waste is given as follows.

Electronic waste which is commonly referred as “e-waste” is the new byproduct of the InfoTech society. It is a physical waste in the form of old discarded, end of life electronics.

Alternatively, it can be defined as “E-waste is electronic waste. It includes a broad and growing range of electronic devices from large household appliances such as refrigerators, air conditioners, cellular phones, computers and other electronic goods”.

Similarly , e-waste can be defined as the result when consumer , business and household devices are disposed or sent for re-cycling example , television, computers , audio-equipments , VCR,DVD, telephone, Fax, Xerox machines, wireless devices, video games, other household electronic equipments. All the above definitions explain about electronic goods which are used and discarded when new electronic goods are bought.

1.2. Solid waste and e-waste

Solid waste contains dry and wet solid waste and it is regularly collected from the dustbins and common area. The dry waste can be composted whereas the wet waste can be send to the landfill sites (Plesea and Visan, 2010). Solid waste is not much harmful for human being as compare to e-waste. E-waste has been categorized into ten categories. The main e-waste categories are large household appliances, IT and telecom and consumer equipments. Refrigerator and washing machine represent large household appliances, personnel computer monitor and laptop represent IT and telecom, television represents consumer equipment (Pinto, 2008). The e-waste has high material complexity and toxicity. Such toxic creates serious pollution upon disposal. Most types of the e-waste contain a combination of low and high value of hazardous material like Pb, Hg and plastic etc. The Pb is considered major element of the glass of CRT's and it is a part of monitor. Another component in many e-wastes is printed wire boards (PWBs) which contain lead (Pb) and brominates flame retardants

(BFRs). These hazardous materials in the obsolete electronics can be realized to the environment during disposal. It can cause an adverse impact to human and environment.

1.3. Objectives of study

The main objective of the study is to understand the disposal of end of life appliances which includes their collection, financing and recycling through the description, analysis and comparison of the prevalent practices. The other objectives are explained as follows.

1. Identify the actual quantity of e-waste in Mumbai Metropolitan Region
2. Study the present e-waste management practices and different risks associated with it.
3. Estimate the future e-waste generation in region
4. Suggest new e-waste management system for long term in MMRDA.
5. Suggest alternative solutions for end users , manufactures and producers of e-waste

1.4. Aim of study

The study has major aim to understand the process of buying of a product to disposal of e-waste. This paper aims to suggest policies to increase the awareness among the citizens, producers and manufacturers. Some technical, administrative and legal measures must be taken into consideration. The efforts would be to promote the use of environment friendly design, material and energy in electronic products. They are easy to dispose. Similarly the study also aims to suggest the methods for building knowledge sharing of e-waste at regional and municipal level. The knowledge base will include guidelines, and good practices on e-waste management. Capacity building activities will be last part and it includes training, awareness program etc.

2. E-WASTE VALUE CHAIN AND MANAGEMENT

E-waste management is more complex than the household solid waste. There are different companies which are producing the electronic goods. They have their own production units and they always do research and development and produce the new machines or products. The manufacturers purchase the inputs and manufacture various finish products. Most of the manufacturers assemble electronic products. All consumers buy the products from the manufacturing unit and producer. Some producers also produce the finish products and sell directly to consumer. Some consumers import the various electronic goods. They are much cheaper and quality of electronic goods is good.

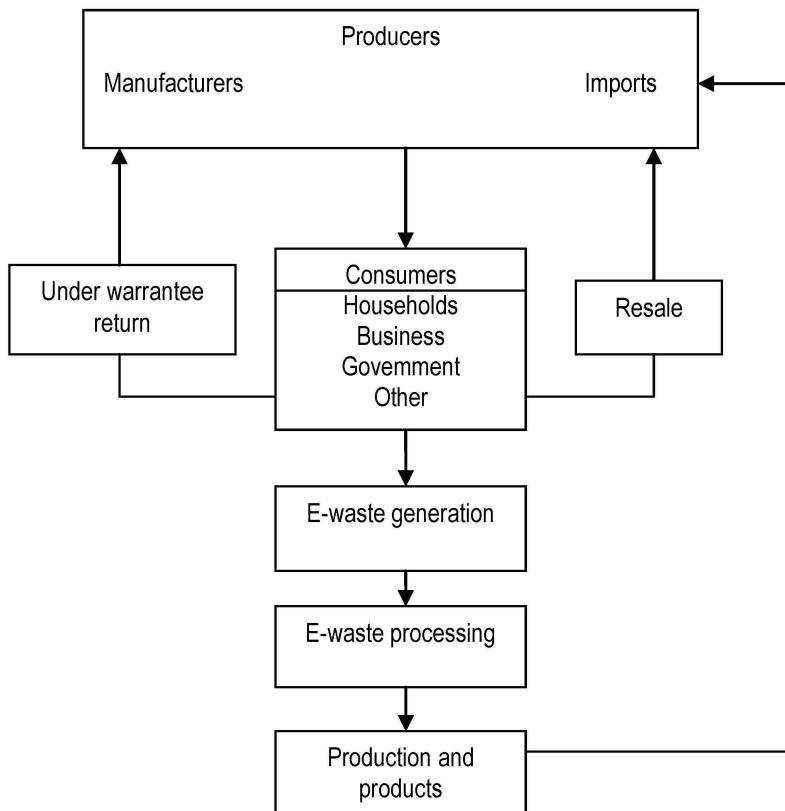


FIGURE 1 - E-WASTE VALUE CHAIN

All the consumers such as households, business houses, government and others buy the products from the manufacturing units or directly from producers. The importers of electronic product are low in percent. Sometimes companies take the product back if it is not working or for any damage. It is returned back to the same company because it is under warranty period. Similarly some manufacturing units and companies accept the old product and sell new products. Sometimes only old products are sold to retailers. There is social benefits to secondary markets especially computers, as they make goods available to low income people raising standards of living. Given that unregulated processing in developing countries income, there is strong economic pull driving the creation of an informal sector which poses a challenge for enforcement of regulations (Williams E.2005). But replacement and demand for old products is again in limited quantity in India. It is because products are purchased at one place and used at other place. Secondly, the cost of carrying the product is high and actual money value of old product is low. Therefore electronic products are directly thrown in the dustbins. If they are segregated then e-waste processing can possible. Such processed products of e-waste and parts can be used in production of other products. At present, a law is passed for the e-waste management in India. It is presently interpreted under the hazardous waste (HW) rule. In practice, e-waste is put in dustbins and it is largely handled by people of informal sector. Similarly lack of

awareness among people, e-waste is put into storage and awaited till disposal. It is sent to landfill or incinerated. Thirdly it reused either second hand product or refurnished. Some e-waste is recycled at recycling facilities. But the recycling capacity is very low in region. The main challenge of e-waste is the lack of awareness in relation to environment, social and economic aspect. The awareness is low among public, consumers, producers, institutions, policy makers and legislators. The availability of skilled manpower for recycling and adequate technologies is limited in region. In future it is possible to make recycling of e-waste a profitable business.

3. ECONOMETRIC METHOD

We have developed econometric method to estimate the e-waste in Mumbai Metropolitan Region (MMR). It is as follows,

$$\sum_{t=1}^{ew} = sw * \frac{(ew * 1)}{100} \quad (1)$$

Where

ew: Total e-waste generated in region

sw: Total solid waste generated in region and it is measured in terms of Metric Tons (MT)

We have calculated the e-waste generated from the solid waste. It is one percent of the total solid waste in region.

Alternatively

$$\sum_{t=1}^{ew} = \sum_{t=1}^i (P + S + I + A + T + H) * 1 \quad (2)$$

Where

ew: It is e-waste generated in region at time t

P: Population of region at time t

S: Shops and malls in region

I: Number of industrial units in region

A: Number of Schools, colleges and other educational institutions in region

T: Theaters in region

H: Health care institutions in all municipal corporations

Total population, shops and malls, industrial units, educational institutions, theaters and health care institutions gives the e-waste generation in particular time. We have multiplied the number of unit and

type of unit with e-waste generation capacity. E-waste generated by per capita in region is one kilo gram per annum. We have multiplied it with number of unit, population and visiting population to such units in region.

4. DATA COLLECTION AND ANALYSIS

Data for this study is collected from the secondary sources. There are various reports related to e-waste, environment status report and city development report of Greater Mumbai, Thane, Ulhasnagar, Kalyan-Dombivali, Navi-Mumbai, Mira Bhayandar and Bhiwandi-Nizampur Municipal Corporation used. The Census 2011, 2001, 1991 provides the population of Municipal Corporations of Mumbai Metropolitan Region. Similarly 2001 census provides the number of units of theaters, hospitals, educational institutions, shops and malls and industrial units in each ward. We have estimated the total growth of the various units based on the annual growth rate. The e-waste generation is calculated based on the per unit e-waste. The alternative method of e-waste is also used as the proportion of e-waste to total solid waste in each Municipal Corporation. We have used the Ordinary Least Square (OLS) method to examine the co-related factors with e-waste in Municipal Corporations of metropolitan region.

5. ESTIMATION OF E-WASTE

We have estimated the annual e-waste generated in each Municipal Corporation based on the above methodology. We have estimated the electronic waste in Greater Mumbai, Thane, Kalyan-Dombivali, Navi-Mumbai, Mira-Bhayandar and Bhiwandi-Nizampur Municipal Corporation.

TABLE 1 - ESTIMATION OF E-WASTE IN MUNICIPAL CORPORATION (MT) (2012)		
Municipal Corporation	Total e-waste	Percent
Greater Mumbai	31622.40	66.62
Thane	3598.59	7.58
Kalyan-Dombivali	3282.73	6.92
Ulhasnagar	1769.15	3.73
Navi-Mumbai	3254.11	6.86
Mira-Bhayandar	2006.64	4.23
Bhiwandi-Nizampur	1935.18	4.08
Total	47468.80	100.00

Source: Compiled from data

Above table shows that annually, Mumbai city has 31622.4 Metric Tons (MT) e-waste. It is highest in terms of all other municipal corporations in region. It is high because total population, shops, hospitals, malls, educational and small industrial units in city. There are many software and IT industrial units

generating e-waste in city. In Thane Municipal Corporation, the estimated e-waste is 3598.59 MT. It is again because of growth of population and other units in the corporation area. In Kalyan-Dombivali, the estimated E-waste is 3282.73MT. In Ulhasnagar, the E-waste is 1769.15 MT per year. In Ulhasnagar Corporation area, there are IT and software companies. Traditional industries such as textile, food articles, cosmetic, automobile, and chemical industries do not produce much e-waste. Therefore e-waste is moderate in corporation area. In Navi-Mumbai municipal corporation area, the estimated e-waste is 3254.11 MT per year. The city is modern but density of population is low. Therefore e-waste generated is low. But in future population and e-waste will rise. In Mira Bhayandar Municipal Corporation, the annual estimated e-waste is 2006.64MT. In Bhiwandi-Nizampur Municipal Corporation, the estimated e-waste is 1935.18MT per year. Bhiwandi city is famous for the textile units. Such units do not produce much e-waste. Total annual e-waste estimated in Mumbai metropolitan region is 47468.8 Metric Tons (MT) per year. It is further separated according to different components of each municipal corporation.

TABLE 2 - E-WASTE ACCORDING TO DIFFERENT CONSTITUENTS IN BMC (MT)

Constituents	E-waste (MT) annual	Percent
Population	20214.00	63.92
Slums	5122.80	16.20
Academic institutions	464.76	1.47
Industry	486.00	1.54
Theaters	133.20	0.42
Shops and malls	4359.60	13.79
Hospitals	298.80	0.94
Welfare and government institutions	543.60	1.72
Total	31622.76	100.00

Source: Compiled from data

In Brihanmumbai Municipal Corporation, population contributes 20214MT e-waste. People are using the various electronic items such as mobile phones, television, washing machine, refrigerators, computers and laptops. The replacement of electronic items is higher in city. It depends on the income of households. The annual e-waste by slums is 5122.8MT. The solid waste is not regularly collected in slums of Mumbai city. Therefore data of e-waste generated by slums and collection is not available. The e-waste from academic institutions is 464.76 MT annually in Mumbai Municipal Corporation. There are many schools, colleges, and other educational institutions which use computers, LCD, laptops, fax machines, printers for different purposes. Now e-learning and new methods of teaching are based on the technology. Most of the electronic items are used in the academic institutions. We have also estimated the e-waste generated by the industry which is 486MT. The e-waste by the theaters is 133.2

MT. Shops and malls are also contributing to e-waste and it is 4359.6MT. Hospitals also contributing the e-waste which is calculated as 298.8MT. The welfare centers and government institutions are also contributing the e-waste and it is 543.60MT. There are different government departments in the city which are using the electronic goods. When grants are given, the old electronic products are replaced with new products. The old products are discarded in the dust bins. Total annual e-waste generated in the city is 31622.76 Metric Tons (MT).

6. E-WASTE GENERATION IN THANE DISTRICT

We have also estimated the e-waste in Thane district according to different constituents in each municipal corporation. The municipal corporations and constituents of e-waste generated are explained in the following table.

TABLE 3 - E-WASTE GENERATION ACCORDING TO CONSTITUENTS IN MUNICIPAL CORPORATIONS OF THANE DISTRICT (MT)

Constituents	Thane	Kalyan-Dombivali	Ulhas Nagar	Navi-Mumbai	Mira Bhayandar	Bhiwandi-Nizampur	Total
Population	2788.81	2382.8	937.94	2272.57	1401.59	1324.94	11108.65
Industry	317.09	469.55	595.69	568.15	350.39	331.24	2632.11
shops	39.56	37.12	32.65	24.95	41.98	33.44	209.7
Theaters	44.82	46.76	54.11	27.18	53.57	52.38	278.82
Preschool	71.71	60.55	29.45	71.71	35.64	33.66	302.72
Secondary schools	64.84	57.28	27.83	67.82	33.66	31.86	283.29
Colleges	9.4	5.8	2.81	6.88	3.38	3.2	31.47
Post graduate institutions	8.57	6.05	2.95	7.16	3.53	3.35	31.61
Hospitals	253.8	216.83	85.72	207.68	82.91	120.56	967.5
Total	3598.59	3282.73	1769.15	3254.11	2006.64	1935.18	15846.4

Source: Compiled from data

Table 3 shows that in Thane Municipal Corporation, the population contributing 2788.81MT e-waste annually. In Thane city, migration of population is high. People use electronic goods in their daily routine activities. Due to proximity to financial capital, the use of mobiles, laptops, computer's is higher in city. In Ulhasnagar Municipal Corporation area, there are different IT parks and software companies. Most of the IT firms are contributing maximum e-waste. We have estimated that industry would be contributing 595.69 MT in Ulhasnagar Municipal Corporation. Shops have 41.98MT e-waste in Mira Bhayandar area. The density of electronic shops in such Municipal Corporation is very high. In Ulhasnagar city, due to industrial and manufacturing units there are many mini theaters. They generate e-waste which we have estimated annually as 44.82 MT. E-waste by primary schools in each Thane and Mira-Bhayandar

Municipal Corporation area is 71.71MT respectively. Secondary school contributes 67.82MT e-waste in Navi-Mumbai Municipal Corporation area. Colleges have 9.4MT annual e-waste in Thane Municipal Corporation. In Thane city, numbers of college students are higher. They required computers, LCD, printers during their study. Most of the educational institutions are providing all the inputs to students but its use ultimately add in e-waste generation. Post graduate institutions have 8.57MT e-waste in Thane Municipal Corporation. Hospitals contribute 253.8MT annual e-waste in Thane Municipal Corporation. Thane city has two big public hospitals and many private hospitals. Many patients are regularly take treatment in such hospitals. The e-waste generated is high in corporation area. The lowest e-waste is generated by hospitals in (82.91MT) Mira-Bhayandar Municipal Corporation. Most of the people from western region take treatment in hospitals of Mumbai city. Most of the hospitals are modern and provide treatment on various health problems .The number of hospitals and dispensaries in the Mira-Bhayandar Municipal Corporation are less therefore e-waste generation is very low. In Thane district, Population of six Municipal Corporation contributes 11108.65MT e-waste annually which is highest in terms of total volume. The lowest e-waste is contributed by the colleges of six Municipal Corporations which is 31.47 MT annually. Colleges have few computer labs, printers, fax machines etc. where e-waste generation is low. Therefore e-waste generated by colleges is very low in Thane district.

7. REGRESSION RESULTS

In order to examine the co-relation of e-waste with other constituents in all municipal corporations, we have used the Ordinary Least Square (OLS) method (Greene, W. H. 2003). The model is given as follows:

$$\sum_{t=1} ew = a + \beta_1 pop + \beta_2 I + \beta_3 H + \beta_4 A + \beta_5 S + \beta_6 T + \varepsilon \quad (3)$$

Where

$\sum_{t=1} ew$: total e-waste in all municipal corporations of Mumbai Metropolitan Region at time t. It is used as dependent variable.

- Pop: Population in all municipal corporations in the region
- I: Industrial units in all municipal corporations
- H: Hospitals and visitors to hospitals in all municipal corporations
- A: Academic institutions of municipal corporations of metropolitan region.
- S: Shops and malls in the municipal corporations
- T: Theaters in all the municipal corporations
- ε : Error term in least square equation

We have regressed independent variable on dependent variables and the results are explained in the following table.

TABLE 4 - ORDINARY LEAST SQUARE (OLS) REGRESSION RESULTS

Variables	Co-efficient (Standard error)	T test
Population	1.68*(0.00)	2005.75
Constant	-14856.28(53.00)	-280.27
R-square=1.00 Adjusted R-square = 1.00 Root MSE=78.48		

* Significant at 1 percent

Above table shows that the population in all municipal corporations in metropolitan region is positively co-related to the e-waste generation. It is because the growth of population is higher in metropolitan region. Migration in metropolitan region is very high. People use mobile phones, purchase washing machines, LCD, refrigerator, computers and laptops. They discard different electronic items in short period due to high income growth. Therefore e-waste generated by per capita is very high in region. The e-waste generated by population is positively co-related to total e-waste generated in region and it is statistically significant. Population visiting malls, shops, theaters, health care and educational institutions is in proportion with population growth. There is multi-co linearity with the ordinary least square regression. Therefore all other variables are not statistically significant. It is limitation of this study.

8. FUTURE ESTIMATION OF E-WASTE

E-waste will increase as economies grow and new technologies are developed (Robinson B.H.2009). In order to develop capacity and awareness of e-waste, we have calculated future e-waste in all six Municipal Corporations. We have used the per capita e-waste generated, annual growth and number of units in each municipal corporation. It is explained in the following table.

TABLE 5 - E-WASTE ESTIMATED FOR FUTURE PERIOD (MT PER YEAR)

Municipal Corporation	2021	2031	2041	2051
Mumbai	46663.20	63163.20	79663.20	96163.20
Thane	4969.94	6406.34	7842.74	9279.14
Kalyan-Dombivali	4466.52	5686.52	6906.52	8126.52
Ulhasnagar	2825.46	3897.86	4970.26	6042.66
Navi-Mumbai	4202.31	5154.91	6107.51	7060.11
Mira-Bhayandar	2961.02	3907.12	4853.22	5799.32
Bhiwandi-Nizampur	2797.27	3670.27	4543.27	5416.27

Source: Compiled from data

Table 4 shows that E-waste in Mumbai metropolitan region is increasing fast due to number of reasons. It is important to consider e-waste for different Municipal Corporations and periods. In 2012, the e-waste generated in Mumbai city is 31622.40MT but in 2041, it will reach up to 79663.20 MT. In 2051, it will be

96163.20MT. In city, the use of electronic items will rise very fast. Due to high income, standard of living and work preference, people will replace and buy electronic items. In Thane Municipal Corporation, the e-waste in 2012 is estimated as 3598.59MT. In 2051, it will be 9279.14MT. In Thane population, academic institutions and hospitals are the main drivers of e-waste. In Kalyan-Dombivali Municipal Corporation, the e-waste generated in 2012 is 3282.72MT. In 2051, e-waste in such municipal corporation will rise up to 8126.52MT annually. Industrial units will contribute more e-waste in this area. In Ulhasnagar, the e-waste in 2012 is estimated as 1769.15 MT but in 2051, it is estimated as 6042.66MT. Population growth and industrial development are the major determinants of e-waste in the area. In Navi- Mumbai, the e-waste in 2012 is 3254.11MT. In 2051, it is estimated as 7060.11MT. Navi Mumbai is a modern and planned city in MMR. It is twenty first century city, therefore population, theaters, education institutions will rise fast and therefore the e-waste generation would be very high. In Mira-Bhayandar Municipal Corporation, e-waste is 2006.64MT in the year 2012. But in 2051, it is estimated as 5799.32MT annually. There is moderate growth of all the constituents in corporation area till 2051. The e-waste will rise moderately and same along with other municipal corporations. In Bhiwandi-Nizampur, the e-waste is 1935.18MT in 2012 but in 2051, it is estimated as 5416.27MT. Again in this municipal corporation, there is moderate rise in the e-waste till 2051. In 2051, e-waste will be double of present e-waste in all municipal corporations of Mumbai Metropolitan Region. E-waste generation in Ulhasnagar, Mira-Bhayandar and Bhiwandi-Nizampur Municipal Corporation will be almost same in 2051. Such huge amount of e-waste in region sparks number of issues and problems. If e-waste issue is not taken seriously then metropolitan region will have water, air pollution. It will also affect on health of human being.

9. POLICIES

The continuous dependence on electronic equipments at home and in the workplace has given rise to a new environmental challenge: Electronic waste (Peralta G.L. and P.M.Fontanos 2006).E-waste in Mumbai metropolitan region is rising fast. The population, hospitals, industrial units, shops are rising in terms number. They generate e-waste during their day today economic activities. Maximum e-waste by the households, commercial units, hospitals and shops is thrown in the dustbins. It is further transferred with solid waste to landfill sites. Some proportion of e-waste is collected by the waste pickers. But maximum e-waste is sent for land filling which is sometimes burned. E-waste pollutes air, water and land. It has hazardous effect on human health. The current practices and e-waste management suffer from a number of drawbacks like the difficulty in inventorisation, unhealthy conditions of informal recycling, inadequate legislation, poor awareness and reluctance on part of the corporate to address the

critical issue (Joseph K.2007). There is need of different alternative policies from the suppliers to the recyclers. Suppliers of e-waste must provide manufacturers with environmental friendly material and components. Manufacturers can influence the electronic product by design, material choice, manufacturing processes, product delivery and product system support. In city, people will purchase electronic goods which will available to them. Product system should reduce the toxicity and energy use. It is very high in present electronic goods. The electronic products must be available for reuse and exchange. While buying the electronic products, manufacturers should assure on printed bill that they will take product back after specific time period. Manufacturers must reuse components and materials of old electronic products. For example, recycled plastic must get reused in new products. It is usual task which is done in different industries. Manufacturers should give incentives to their customers for all electronic product return through a "buy back approach" in Mumbai metropolitan region. The old electronic goods can be collected and discount could be given on new products purchased by the consumers. It is easy to give old product and get the new with additional features in product. Government should make compulsory to all the vendors in all municipal corporations to take back their old electronic devices/ products. Such products should be periodically taken at the end of life of all electronic products. The old and not working electronic product should then send to recycling. Some products need a separate and some products need a common facility for recycling. Municipal corporations should first send products at common recycling center. Recycled products must be sold to the manufacturers.

E-waste collection system needs to be established so that e-waste can be collected from the right place. Municipal corporations must provide yellow bins at common places in their respective area. They must be under the plastic shade so that the rain water will not harm e-waste. Each municipal corporation should ensure the zero e-waste in city. Collection centers should be well located with particular distance in city. There should be separate vehicles and workers to collect e-waste regularly from such bins. All collected e-waste should be send to the recycling unit.

Most of the e-waste can be recycled with proper technique. Many discarded machines contain usable parts which could be salvaged and combined with other used equipment to create a working unit. It is very easy but it is labor intensive task to remove or break the parts of machines. Skilled workers required to inspect and test components and then reassemble them into complete working machine. Institutional infrastructure including e-waste collection, transportation, treatment, storage, recovery and disposal need to be established at regional level. It will solve the recycling issue of electronic goods. Established recycling center should get support of NGO's, government and private sector. Private

sector is interested for investment in the e-waste projects. But they must be made sure of their financial returns.

The future of e-waste management depends on Municipal Corporations. The attitude of citizens is also important. The key role of manufacturers and bulk consumers is required to shape and develop community participation. It will help to collect maximum e-waste from corporation area. But lack of civic sense and awareness among city residents is a major hurdle to keep e-waste out of municipal waste stream. Collaboration campaigns are required to sensitize the users. Consumers in all corporations should pay some amount for recycling of electronic goods. It will be economically viable project. Consumers need to be informed of their role in the e-waste management. Consumers need to be educated to buy only necessary products that utilize some of the emerging technologies to be identified through eco-labeling.

Awareness raising programs and activities on issues related to the environmentally sound management health safety aspects of e-waste are required in region. Such awareness and campaign for better management is required for different target groups. Government, citizens, recyclers, waste collectors, municipalities' producers and all other stakeholders should be made aware of the e-waste problem in society. It will help to solve e-waste problem at some extent. This will be all the more feasible and transparent and well known e-waste solutions index (Gossart G. and Huisman J. 2011). Municipalities should introduce an additional container which private households can drop of metals, woods, textiles, plastics and small e-waste appliances such as toasters, mixers, shavers, mobile phones after removal of the batteries. Different approaches should be allowed private households for disposal of small e-waste appliances and other valuable materials together with packaging materials in the bins. Some municipalities offer household collections of such specific items from time to time they announce the date and private households can place their waste items on the street for pickup. Private households can also call up the municipal waste collection authorities to pick up items from their household. This service normally has to be paid off (Deubzer, 2011). It is better to have the different solutions for e-waste in all the different municipal corporations. It will help to reduce the e-waste problem in metropolitan region. E-waste free cities always improve standard of living, health outcome and economic growth.

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