E-WASTE: AN ENVIRONMENTAL AND ECONOMIC OVERVIEW ON GENERATION AND RECYCLING FOR DIFFERENT INDIAN STATES

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Abstract : E-waste is a growing global problem. It is estimated that 50 million tons of e-waste was generated globally in 2018. . Despite 66 per cent of the world's population being covered by e-waste legislation, only 20 per cent of global e-waste is recycled each year. E-waste generation and recycling is different for different Indian states and depends on lot of economic factors. This study shows that environmental problem due to e-waste generation is closely linked with the economic conditions of the state. Demographic dividend can help India in mitigation of this problem.

***Index Terms* – E-waste, GDP, PCI, IT, population, recycling.**

1. INTRODUCTION

Growth in the IT and communication sectors has enhanced the usage of the electronic equipment exponentially. Faster upgradation of electronic product is forcing consumers to discard old electronic products very quickly, which, in turn, adds to e-waste to the solid waste stream. The growing problem of e-waste calls for greater emphasis on recycling e-waste and better e-waste management. Electronic waste or e-waste is generated when electronic and electrical equipment become unfit for their originally intended use or have crossed the expiry date. E-waste typically consists of metals, plastics, cathode ray tubes (CRTs), printed circuit boards, cables, and so on. Valuable metals such as copper, silver, gold, and platinum could be recovered from e-wastes, if they are scientifically processed. Consumers are the key to better management of e-waste. Initiatives such as Extended Producer Responsibility (EPR); Design for Environment (DfE); Reduce, Reuse, Recycle (3Rs),technology platform for linking the market facilitating a circular economy aim to encourage consumers to correctly dispose their e-waste, with increased reuse and recycling rates, and adopt sustainable consumer habits. International treaties such as Basel Convention aim at reducing and regulating the movement of hazardous waste between nations. Even with the Convention, illegal shipment and dumping of e-wastes continue to take place. It is estimated that 50 million tons of e-waste was generated globally in 2018. In addition, India is ranked fifth in the world amongst top e-waste producing countries after the USA, China, Japan, and Germany and recycles less than 2 per cent of the total e-waste it produces annually formally. E-waste collection, transportation, processing, and recycling is dominated by the informal sector. There is a requirement of various industrial units to recycle e-waste. In developing countries like India collection of e-waste is a problem due to prevailing waste management practices. Huge population and large number of people willing to work in India may play a vital role in development of e-waste recycling industries.

2. ABBREVIATIONS AND ACRONYMS

E-waste : Electronic Waste
GDP : Gross Domestic Product
PCI : Per Capita Income
IT : Information Technology

3. RESEARCH METHODOLOGY

3.1 Data and Sources of Data

The study has been done from January 2020 to May 2020. Data was collected from FY 2016- 2017 to FY 2018-19. Before studying the e-waste and its recycling concept, electrical and electronic products sells analysis was done to fathom the market penetration of these goods in India. Table 1 and figure 1 shows the data regarding e-waste generation and recycling for major Indian states.

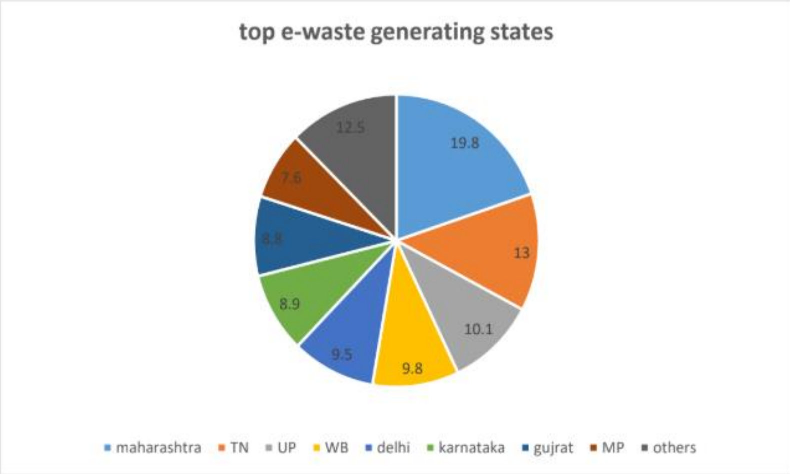

Figure1: percentage e-waste generated by major Indian states

Table 1

S.NO.	STATE	E-WASTE GENERATED, 2018 THOUSAND (MT)	E-WASTE RECYCLED, 2018 (THOUSAND MT)	PERCENTAGE RECYCLED	POPULATION (MILLION)	PER CAPITA E-WASTE GENERATED (1000MT/million)	GDP (LAKH CRORE)	PER CAPITA E-WASTE RECYCLED (1000TONNES/MILLION)
1	**MAHARASHTRA**	8850.6	47.81	0.54	124.9	70.86	29.79	0.382786229
2	**TAMIL NADU**	5811	52.427	0.9	82.4	70.52	17.25	0.63625
3	**UTTAR PRADESH**	4514.7	86.13	1.91	228.1	19.79	15.79	0.377597545
4	**WEST BENGAL**	4380.6	10	0.23	99.8	43.89	13.14	0.100200401
5	**DELHI**	4246.5	49.185	1.16	19.2	221.17	7.8	2.56171875
6	**KARNATAKA**	3978.3	44.62	1.12	68.7	57.91	15.88	0.649490539
7	**GUJARAT**	3933.6	37.262	0.95	65	60.52	17.02	0.573261538
8	**MADHYA PRADESH**	3397.2	8.985	0.27	83.7	40.59	9.62	0.10734767
9	**RAJASTHAN**	3141.5	68.67	2.19	79.6	39.47	9.29	0.862688442
10	**HARYANA**	2238.1	49.981	2.23	28.5	78.53	7.84	1.753719298

3.2 Theoretical framework

Correlation between sets of data is a measure of how well they are related. The most common measure of correlation in stats is the Pearson correlation. The full name is the Pearson Product Moment Correlation (PPMC). It shows the linear relationship between two sets of data. Correlation coefficient formulas are used to find how strong a relationship is between data. The formulas return a value between -1 and 1. A correlation coefficient of 1 means that for every positive increase in one variable, there is a positive increase of a fixed proportion in the other. For example, shoe sizes go up in (almost) perfect correlation with foot length. A correlation coefficient of -1 means that for every positive increase in one variable, there is a negative decrease of a fixed proportion in the other. For example, the amount of gas in a tank decreases in (almost) perfect correlation with speed. Zero means that for every increase, there isn't a positive or negative increase. The two just aren't related.

Equation

Coefficient of correlation, $r = \frac{n\sum(XY)-(\sum X)(\sum Y)}{\sqrt{\{(n\sum X^2-(\sum X)^2)(n(\sum Y^2-(\sum Y)^2)\}}}$ …. (equation 1)

Here,

n = no. of observations or no. of set of data

X = independent variable

Y = dependent variable

$\sum$X = sum of all X values

$\sum$Y = sum of all Y values

$\sum$ XY = sum of product of all XY values

$\sum X^2$ = sum of all square of X values

$\sum Y^2$ = sum of all square of Y value

3.3 Statistical Tools

3.3.1 Stratification

Stratification is a data sorting process that involves arranging the data into some meaningful order to make it easier to understand, analysis or visualize. When working with research data, sorting is a common method used for visualizing data in a form that makes it easier to comprehend the story the data is telling.

3.3.2 Scatter diagram

The scatter diagram graphs pairs of numerical data, with one variable on each axis, to look for a relationship between them. If the variables are correlated, the points will fall along a line or curve. The better the correlation, the tighter the points will hug the line.

4. RESULTS AND DISCUSSION

4.1 Effect of population on e-waste generated by a state

By using the equation (1), we find out the coefficient of correlation of population of a state in million and E-waste generated by the state. We find that r is 0.364. From the above graph and value of coefficient of correlation, r, we can say that there is a positive correlation between population and e-waste generated but this correlation is not very strong. Therefore, higher population not necessarily translates into higher e-waste generation as for e-waste to generate at a first place; there should be equivalent consumption of consumer electronic goods.

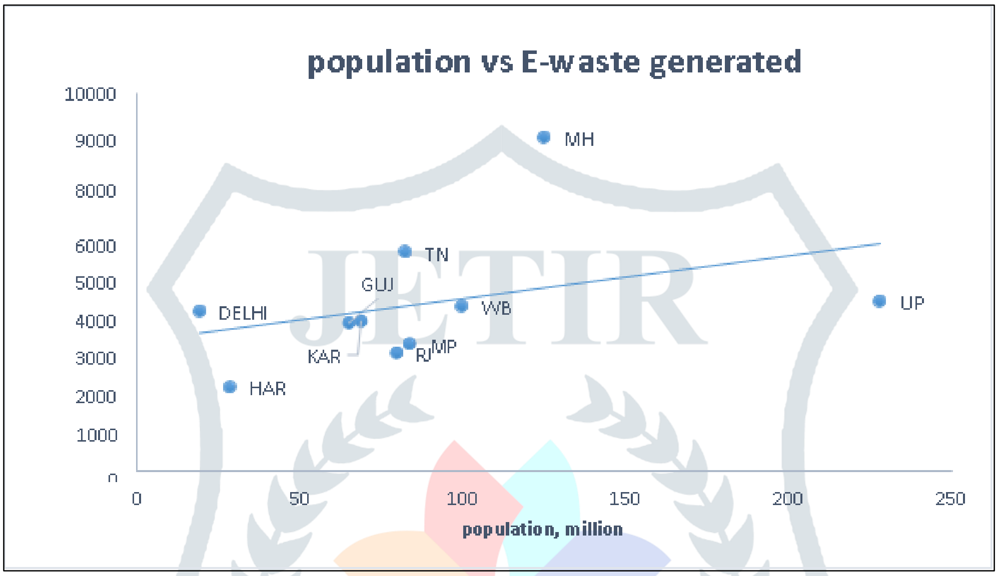

Figure 2 : scatter diagram for population vs e-waste generated

4.2 effect of GDP on e-waste generated by a state

By using the equation (1), we find out the coefficient of correlation between GDP of state in rupees lakh crore and E-waste generated by the state. We find that r is 0.909. From the above graph and value of coefficient of correlation, we can easily say that e-waste generated in a state is directly proportional to the Gross Domestic product, GDP of that particular state. GDP is the measure of economic activities of a state. More GDP means that the state is richer and hence collective purchasing power of that state is more. More money means more expenditure and this some of this money goes towards purchase of electronicand electrical goods. More e-goods in use create more e-waste over a period of time.

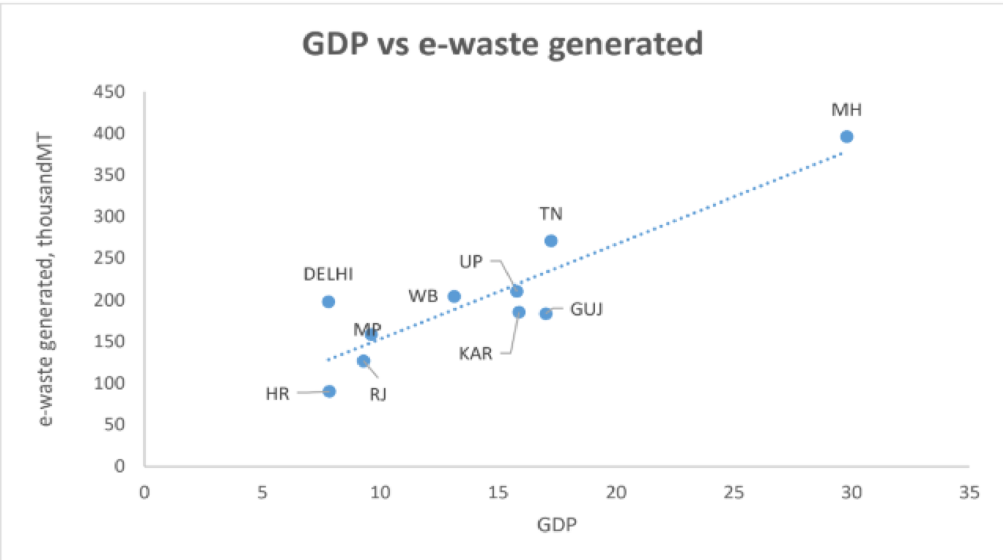

Figure 3: scatter diagram for GDP vs e-waste generated

4.3 E-waste recycled by different states vs. 2018 government target

According to amendments in e-waste management rules 2016 in 2018, 10% recycling criterion is set for year 2018 with 10% increase in recycling every year until it reaches to 70% in 2023.
From table 1, we can draw a graph

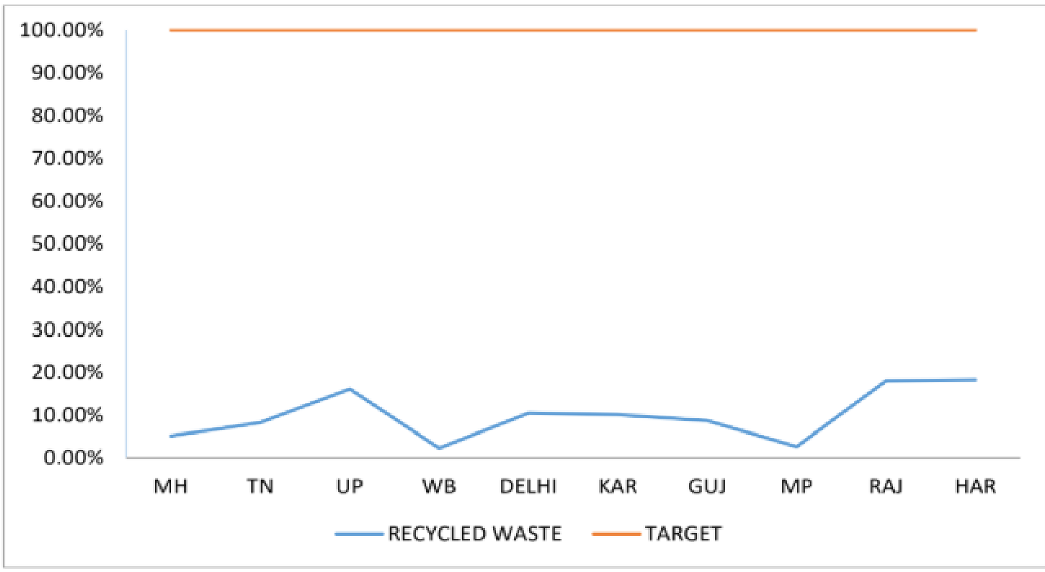

Figure 4: line graph showing target and actual waste recycled by states in 2016

4.4 effect of PCI on per capita e-waste recycled for a state

By using the equation (1), we find out the coefficient of correlation of per capita income of a state to per capita e-waste recycled. The value of r is 0.793. From the graph and value of coefficient of correlation, we can see that there is strong positive correlation between per capita income of a state and per capita e-waste recycled. Poorer states, which have less per capita income, recycle less e-waste per person. Therefore, it could be said that there is wide-open scope to process e-waste and grow new waste recycling industries in poor states.

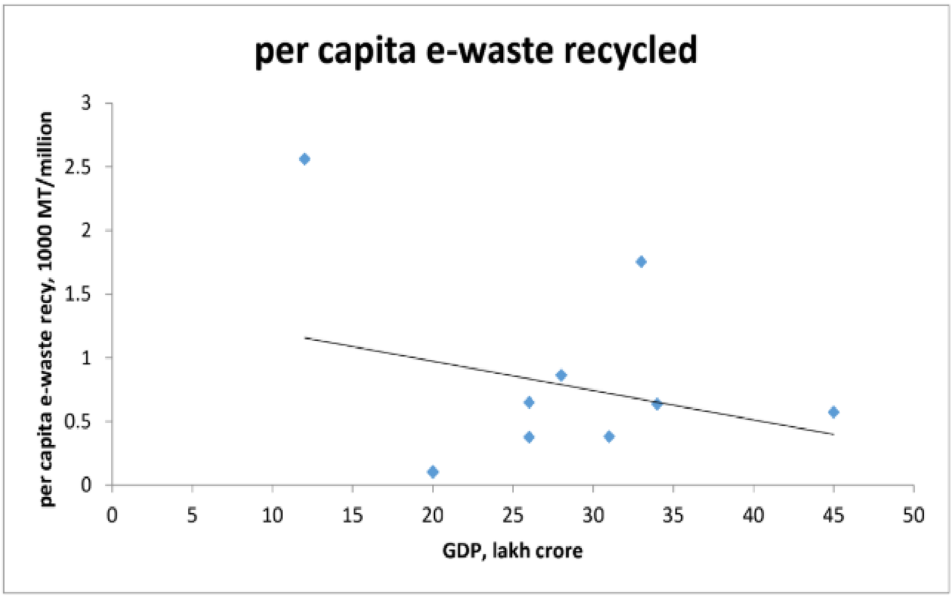

Figure 5: scatter diagram for GDP vs per capita e-waste recycled

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