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New Technology and E-waste: A Case of India

Research Article

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Abstract: In the past couple of decades, new technology in the form of ICT has emerged in a big way. Countries, including India, riding high on ICT face the problem of e-waste. ICT as new technology, accepted as GPT (General Purpose Technology) ushered the world into a new techno-economic paradigm, given its far reaching socio-economic and political implications. ICT is considered as a double edged weapon, i.e. on the one hand, it contributes in growth and development of a country but is a main source growing e-waste on the other hand. According to UNEP, size of global market of e-waste was estimated to be USD 410 in 2011 (excluding the informal sector). High and increasing obsolescence rate, fast changing consumer preferences and introduction of new technologies are the contributing factors in e-waste stream in India. For instance, a single 17 inch monitor PC of 20 kg results in the disposal of 37 kg of non-hazardous waste and 0.7 kg of hazardous waste, nothing but double the weight of the end product. Hence, the health and environmental risks for the society, embedded in e-waste, are enormous in nature and scale. Import of e-waste, largely illegal in nature, is another big policy challenge highlights the other dimension of the problem of e-waste in the country. On the policy front, owing to myriads of socio-economic and political reasons, much is left to be done. In nut shell, given the importance of ICT, time has come to re-think on the associated problem of e-waste, which over the decades has assumed a global face.

Keywords: ICT, E-waste, globalization, environment, society.

1. Introduction

In the last couple of decades, new technology, in the form of ICT, has spread thick and fast. It has been become an integral part of growth and development in most countries including India. However, problem of e-waste resulting from ICT is well-documented. For, any country like India, sustainability of growth riding high on the ICT is questionable. According to the latest NASSCOM Report (2014), contribution of the ICT sector has risen many folds, from negligible in 1995 to 10 percent in 2014. ICT products, given their intrinsic nature and fast changing consumer preferences attract high obsolescence rate. For instance, life span of computers has dropped in developed countries from six years in 1997 to just two years in 2005, and for mobile phones even less than two years (UNEP, 2014). According to one of the TERI-YES Bank Reports (2014), in India, approximately 2.7 million tons of e-waste is generated annually. In other words, new technology and e-waste seemed to be going hand in hand. Over the years, with rising globalization, e-waste, with its multi-dimensional character, has also assumed a global face. In one of a study conducted by EAUC (Environmental Association for Universities and College) in 2008 in U.K., it is revealed total weight of fossil fuels used to manufacture a single desktop PC weights over 240 kg (i.e. 10 times the weight of the computer itself). Analyzing further, it is found that a single 17 inch monitor PC weights 20 kg, results to the disposal of 37 kg of non-hazardous waste and 0.7 kg of hazardous waste, which is nothing but double the

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weight of the end product. Further, as far as the environmental issues are concerned, it is found that manufacturing of same PC requires an estimated 3,244 MJ of energy, 926 L of process water and it creates 193 kg of greenhouse gases emission.

The problem of e-waste is just not confined to India but has grown to a global problem, which as per one of the UNEP (2015) is estimated to be of 41 million metric tons 2014, including the illegal trading. The Basel, Rotterdam and Stockholm Conventions define the structure of rules and regulations to track and manage the global flows of hazardous waste. Recently, Solving the E-waste Problem (StEP) initiative, led by the United Nations University, has added new dimensions in the already define rules, given the fast changing global market for other goods and services.

ICT, being accepted as general purpose technology, is responsible for approximately two per cent of world-wide carbon emissions, equivalent to level of carbon emissions emanating from the aviation industry (UNEP, 2014). For any global economy like India, trade (import and export) plays an important role in the growth and development, as being indicated by increasing trade GDP ratio. The literature on e-waste indicates that in the last decade import of e-waste in India has grown many folds (UNEP, 2014, GOI, 2014). Growing trade in e-waste is a multi-faceted problem, hinting mainly towards a pertinent question like why the developed countries are keen in exporting e-waste to developing countries like India or why developing countries are interested in the import of e-waste. In a study commissioned by US the Environmental Protection Agency (EPA) it is found that it was 10 times cheaper to export e-waste to Asia than it was to process it in the United States (US) itself; thus the incentives for e-waste export, both legally and illegally, are enormous (ILO, 2012). Since, e-waste is a source of many valuable metals like gold, silver; hence import of e-waste is on the rise which eventually has become a means of likelihood to many people in urban slums in the country. Quantitatively, It is estimated that, by 2020, India could see a 500 per cent rise in the number of old computers dumped into the country (Schluep et al., 2009). Also, since production (or application) of ICT is technology- intensive; and hence change in ICT results in change in nature of e-waste. For instance, e-waste from desktop is different than what it is from laptop, both in terms or quantity and composition of e-waste.

Keeping in view the far reaching socio-economic implications of e-waste, government has initiated numerous policy measures to identify and control the problem of e-waste. Among all, in the most recent, pertinent and comprehensive, *E-waste (Management and Handling) Rules 2011* , the proposed institutional framework is centered on the concept of PRO (Producer Responsibility Organization). It is an entity intended to have the physical responsibility for the e-waste recycling mechanism by providing forward and backward linkages with all stakeholders involved in the process including the consumers. As of February 2014, a total number of 98 registered recyclers and dismantlers having recycling/ dismantling capacity of 2,93,572 tones are operational in India (TERI-YES Bank Report, 2014). However, compared to the organized sector, unorganized sector constitute a major chunk (nearly 95 percent) of the total e-waste management in the country. This in itself is pose another set of problems, given their modus operandi and the associated health and environmental hazards with it.

The paper begins with role of ICT in growth and development of the country. Definition of e-waste, and its constituents, followed by other issues such as health and environmental hazard linked with it, is discussed in the proceeding section. Thereafter, role of government policies in controlling the problem are discussed. And finally, the issues of the import of e-waste and growing informalization of the sector managing e-waste are discussed.

1.1. Role of ICT in Growth and Development: a Historical Perspective

ICT, *by definition, is the production of goods and services intended to fulfill or enable the function of information processing and communication by electronic means, including transmission and display* . In the last couple of decades, given its use as product and process innovation, ICT is being regarded as general purpose technology (GPT) like electricity, steam engine and railways in the past. In India, witnessing a phenomenal growth rate of over 20 percent it has grown by leaps and bound.

Eventually, its share in total GDP has increased substantially, from 3.4 percent of total GDP in 2000-01 to 7.5 percent in 2011-12; and it is expected to touch a double digit mark (10 percent) in 2015 (NASSCOM, 2015). A close analysis of the data further shows that majority of ICT production (94 percent) comes from the services sub-sectors within the ICT in the form of IT-ITES and the remaining (only 6 percent) from its manufacturing component. It is therefore worth noting that in total organized manufacturing sector GDP, share of ICT manufacturing sector has remained nearly stagnant at around 2 percent since 2000-01. Contrary to this, the share of ICT services sector in total organized services sector has risen significantly to 10 percent in 2007-08 from 6 percent in 2000-01; and is expected to reach 12 percent in 2015 (NASSCOM, 2015).

As far as the absolute size of the ICT production is concerned, as evident from Table-1, it has increased rapidly from Rs. 1182.9 billion in 2003-04 to Rs. 3682.2 billion in 2008- 09, registering a growth rate 21.2 percent in 2007-08 and 25 percent in 2008-09. Post that, owing to uncertainties prevalent in the international market the momentum of high growth rate decelerated for some times; thereafter, it picked up again. In the last two years since 2012 growth rate above 10 percent helped India maintain its global position. As per NASSCOM Annual Report (2014), it constituted 1.5 percent of global electronics production in 2008-09 which went up to over 2 percent in 2014. The growth of ICT sector in India is therefore export driven. Similarly, size of the computer software industry also increased from Rs. 744.9 billion in 2003-04 to Rs. 2735.3 billion in 2008- 09.

As far as the composition of ICT production is concerned, as shown in Table 5.2, consumer electronics, industrial electronics and computers have recorded a big jump in production, which doubled in 2008 over 2003 in all components. In other words, the total electronic production has gone up from Rs. 42,700 Crore in 2003 to 92,130 Crore in 2008. Similarly, the production of software, both for domestic market and export, has also gone up significantly from Rs. 70,500 Crore to Rs. 2,58,000 Crore. Given the impressive growth trend recorded by the ICT sector in India, other tail of the story is that it is a major source of e-waste, apart from wastes from fridge, T.V. and washing machine. It is seen that within ICT, the production of electronics hardware has increased from Rs.438 billion in 2003-04 to Rs.946.9 billion in 2008-09, recording a compound annual growth rate (CAGR) of 16.6 percent. Given this, and owing to high depreciation rate and changing consumer preferences towards new electronic gazettes such as mobile phones, tablets or laptop, e-waste is on the rise in the country.

So, it seems paradoxical, on the one hand ICT is the engine of India's growth, but on the other it is the source of growing e-waste. It, therefore, poses a great policy dilemma towards how to tackle the problem of e-waste without compromising the ICT led growth momentum. Given its health or environmental implications, it has now become a global concern. The way we design, manufacture, use or manage electronics at the 'end of life' needs to be changed in order to maximize the benefit of technological advancement and to minimize all the associated risks in the form of e-waste. From the experience of the OECD countries, it is found that producers of electronics are entrusted with the responsibility for the *end-of-life* management of all the listed goods that generate e-waste; this is called extended producer responsibility (ERP). In other words, ERP has become an international standard.

Back in India, according to CPCB (2013), owing to increasing market penetration and high and increasing obsolescence rate of electronic products, among many, e-waste is the fastest growing waste stream. Given this, as mentioned above, ICT is being considered as a double edged weapon. In the preceding section, the issue of e-waste is discussed threadbare with special reference to the import and the problems associated with its recycling in the unorganized sector.

1.2. Definition and Composition of E-Waste and Trend of E-Waste in India

By definition, according to UNEP, *e-waste is the wastes of electrical and electronic equipments, whole or in part or rejects from their manufacturing units and repair process, which are intended to be discarded.* Further, electrical and electronic equipment is defined as " equipment which is dependent on electrical currents or electro-magnetic fields to be fully functional. E-waste includes all hardware and accessories, including networking equipment, monitors, central processing units (CPUs), printed circuit boards (PCBs), wires, printers, ink cartridges, keyboards, mouse, facsimile and copying instruments etc. In addition to this, it encompasses a wide range of electrical and electronic devices such as cellular phones, personal stereos; and other household appliances such as refrigerators and air-conditioners.

Table 1. **Trend of Production and Growth of the Hardware and Computer Software Sector in India**

	Production (Rs. Bn)					
	Electronic Hardware	Computer Software	Total	Growth over the previous Year	Export of IT/ITES/BPO (US$Bn)	Growth Rate
2003-04	438	744.9	1182.9	21.9	12.7	
2004-05	505	1019.2	1524.2	28.9	17.4	37.0
2005-06	565.6	1337	1902.6	24.8	23.6	35.6
2006-07	660	1780	2440	28.2	31.1	31.8
2007-08	844.1	2114.1	2958.2	21.2	40.2	29.3
2008-09	946.9	2735.3	3682.2	24.5	46.3	15.2
2013-14	1200	5270	5470	19.2	100	

Source: Department of IT, Ministry of Communication and IT, GOI, and Economic Survey, 2014-15.

Table 2. **Electronic and IT production (Rs Cr)**

Items	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Consumer Electronic	14,850	16,500	17,500	19,500	21,950	25,140
Industrial Electronics	5,980	8,300	8,600	10,100	11,530	12,530
Computers	6,600	8,680	10,500	12,500	15,100	14,090
Communication and Broadcasting Equipments	5,150	4,770	6,300	9,200	16400**	24,180
Strategic Electronics	2,670	2,850	3,070	4,500	5,400	6,560
Components	7,450	8,700	8,530	8,600	9,420	9,630
Sub-Total	42,700	49,800	54,500	64,400	63400**	92,130
Export of Software	55,000	75,000	97,000	132,025	158,550	203,330
Domestic Software	15,500	20,500	27,000	35,150	44,510	54,670
Total	113,200	145,300	178,500	231,575	203,060	350,130

Source: Annual Report, 2008-09, Department of IT, Ministry of Communication and IT, GOI.

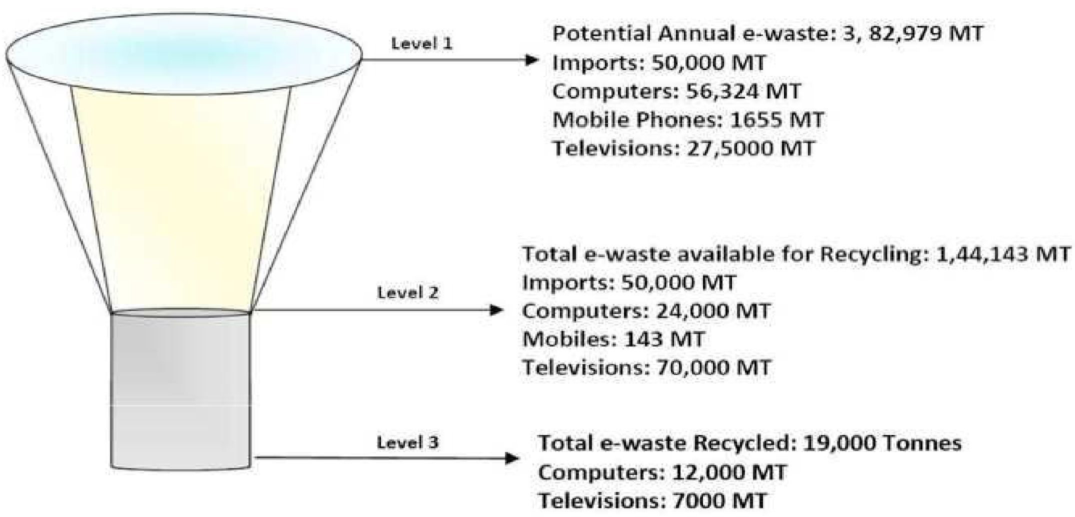
Generally, e-waste contains over 1000 different substances, many of which are toxic, and creates serious pollution upon disposal. It is composed of materials such as plastics, iron, glass, aluminum, copper and other precious metals like silver, gold, platinum, and palladium; and lead, cadmium, mercury etc. These can broadly be classified as 'hazardous' and 'non-hazardous'. According to a Rajya Sabha Report (2011), it is found that iron and steel constitute about 50 percent of the waste, followed by plastics (21 percent), non-ferrous metals (13 percent) and other constituents. Non-ferrous metals consist copper, aluminum and precious metals, like silver, gold, platinum, palladium and so on. The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond threshold limit make e-waste hazardous in nature. *Obsolete computers pose the most significant environmental and health hazard among the e-wastes* (UNEP, 2014). For example, cathode ray tubes (CRTs) are broken down to separate its components like glass, metal and copper. Similarly, circuit boards are disintegrated for gold-plated brass pins, microchips and condensers which in turn are soaked in acid to recover gold and brass separately. Similarly, other components like microchips and condensers are processed to extract other metallic parts. In any country, e-waste is a problem if processed using unhygienic, improper, or unscientific methods for recovery of components embedded in e-waste.

Given the importance of ICT, one study by Shobbana Ramesh and Kurian Joseph, 2006, on the expected life of various ICT products, it is found that low income households use PC for an average 5.94 years, TV for 8.16 years and the mobile phones for 2.34 years while, the upper income class uses the PC for 3.21 years, TV for 5.13 years and mobile phones for 1.63 years. No doubt, given high population base, the per-capita waste production in India is relatively small but in terms of total absolute volume the e-wastes product is enormous. The study further revealed that only about 50 percent of the public are aware of environmental and health impacts linked to electronic items and are therefore willing to pay for e-waste management. The amount they are ready to bear is in the ranges of 3.57 percent to 5.92 percent of the product cost for PC, 3.94 percent to 5.95 percent for TV and 3.4 percent to 5 percent for the mobile phones. In U.S., for instance, it is found that 50 percent of the rejected computers (total computer waste) are in working condition. This is an important input towards framing policy to about the changing consumers' preferences and their readiness to bear additional cost burden towards e-waste management in India.

Growing at 9 percent, India has become the second fastest economies in the world after China. Given huge demand for electronics as being indicated by ever increasing tele-density, computer-density; and the associated high depreciation and fast change in technology, e-waste is growing exponentially. Till 2010, no official data was available on the level and growth of e-waste in India, whatever information available was based on anecdotal studies. According to Basel Action Network article (BAN, 2006b), India generates 2.5 million tons of e-waste per year. As per the CAG Report (2007), over 7.2 million tons of industrial waste, 4 million tons of electronic waste, 1.7 million tons of medical waste, 48 million tons of municipality wastes are generated in the country annually. The Report further says that the ICT sector accounts for nearly 34 per cent of the total e-waste in the country.

The global size of the e-waste market, from collection to recycling, is estimated to be USD 410 billion a year (UNEP 2011), excluding a very large informal sector, which is present at various stages of legal operations. The exact size of the global illegal waste trade is unknown. According to UNEP (2015), approximately 41.8 million metric tons (Mt) of e-waste was generated in 2014 likely to increase to 50 Mt already by 2018. The report further says that the amount of e-waste properly recycled and disposed of ranges between 10 to 40 per cent. In other words, of an average value of e-waste at USD 500 per ton, nearly USD 12.5-18.8 billion (annually) is handled informally or in unregistered sector. .

In India the most accurate and widely accepted estimates on e-waste are from the GTZ Study (2007) of e-waste in India which used ***a three level funnel approach***



Source: Project Report titled: Does the Basel Ban form an effective and sustainable means of addressing the health and environmental problems caused by the export of e-waste from developed countries to developing nations and countries in transition? , by Alexedra Skinner at al (2010)

The first level is based on "potential annual e-waste, which includes products that enter the stream and those others that could potentially enter the e-waste stream but are held by consumers. The second level, e-waste available for recycling, includes all products that have been sold out. Of which, a large amount is refurbished, reused, or resold. The third level, e-waste recycled, is the final level including products and components that are dismantled and recycled each year. The study found that in 2007, 382,979 metric tons (MT) of potential e-waste generated, of which approximately 50,000 MT is imported, largely illegal in nature. Out of this total 'potential annual e-waste', 144,143 MT goes to the next level constituting 24,000 MT, 143 MT and 27,500 MT as computers, mobiles and television respectively. Further, out of this, 'e-waste recycled' is only 19,000 MT. It needs to be understood that only 5% of waste recycled is handled by formal recyclers and the remaining (approximately 95%) by informal recyclers, which are recorded to be not comply with environmental protection or other health and safety legislation (Khattar et al., 2007).

Further, it is revealed 10 States contribute to nearly 70 per cent of the total e-waste; and 60 percent is generated in more than 65 cites. At the state level, Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab. Similarly, among the top ten cities, Mumbai ranks first followed by Delhi, Bengaluru, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur.

The main sources of e-waste in India are the government, public and private (industrial) sectors, which account for nearly 70 percent of total generation. The contribution of individual households is relatively small at about 15 percent; the rest is contributed by manufacturing sector. Though, as of now, individual households are not large contributor, but they are however potential creators of e-waste and hence, all efforts in this regard should accordingly be initiated. Given this, it is expected that with accelerating growth and its sectoral composition towards industries in general and electronics and electrical industries in particular, e-waste is also expected to rise. The fact can be substantiated by a report of the United Nations predicted that *by 2020, e-waste from old computers would jump by 400 per cent on 2007 levels in China and by 500 per cent in India. Additionally, e-waste from discarded mobile phones would be about seven times higher than 2007 levels and, in India, 18 times higher by 2020 (GOI, 2011).* These predictions highlight the bourgeoning problem of ecological hazards associated with E-Waste in fast developing countries like India.

According to the UNEP, 2014 Report, internationally, China, the fastest economy in the world, produces about 2.3 million tons of e-waste next only to US. It is expected that *US and EU would combined produce the maximum e-waste in the current decade. As per UNEP Report of 2007, per capita e-waste in EU is about 14-15 kg which is far ahead than India where it is in less than one kg.* In the Report it is also found that China, India, Brazil, Mexico and others would face rising environmental damage and health problems if e-waste recycling is left to the vagaries of the informal sector.

ICT is therefore considered a double edged weapon; i.e. contributes significantly to the overall growth and development of the country on the one hand but is a major source of e-waste on the other hand hence posing a big threat to human health and environment, as discussed in the proceeding section.

1.3. Export of ITES and Trading in E-waste: a Policy Dilemma

Today, trade reform is an integral part of development strategy of most countries including India, which since 1991 it has been moving steadfast towards trade reform through initiating various multilateral (or bilateral) arrangements, or by dismantling trade restrictions on the cross boarder flow of goods including plastic goods (Kumar, 2006). Eventually, trade GDP ratio, of which a big chunk being contributed by the export of ICT goods and services, has risen many folds.

High and increasing growth of ICT has been contributing significantly in total export, employment and foreign capital inflows in the country. According to the latest NASSCOM Report, 2014, the export revenue form ICT has risen significantly over the years, from $17.7 billion in 2004-05 to $69 billion in 2011-12 and is expected to cross the $100 billion mark in

2015. Among many, FDI, coming from diverse sources, has been playing a pivotal role. According to AT Kearney's FDI Confidence index, in terms of international trade and competitiveness, India has displaced the U.S. as the second most favored destination in the world after China (GOI, 2012). By 2025, Indian economy is projected to become around 60 per cent the size of the US economy (NASSCOM, 2010). The key factors underlying this growing optimism include big and diversified markets, increased investment (including FDI), and the supporting fiscal and monetary government policies among others (OECD, 2010, Economic Survey, 2014). Over 600 MNCs are reported to be sourcing product development (R&D) and engineering services from their centers in India hence making India a strategic hub for R&D. The ICT industry has enhanced India's credibility as a business destination by creating a fundamentally new model of global 24X7 service delivery and forging relationships with 75 per cent of the Fortune 500 companies (ITU, 2014).

Within this rosy picture of ICT led growth and development also lies a growing problem of e-waste import, a new sub-sector, increasingly becoming mainstay for many poor people in urban slums in developing countries like India, Bangladesh and Sri Lank. Direct import of e-waste is banned in India but the Reports show that metal scraps and waste papers imported for recycling has become means for importing hazardous waste including e-waste. EXIM policy law allows import of old computers (less than 10 years old) for charity. Even there is a provision to import computer under the tariff act, but the law is silent on the import of old computer. According to United Nation Environment Report (2012), globally, about 20-50 million tons of e-wastes are disposed off each year, accounting for nearly 5 percent of all municipal solid waste. Studies also revealed that developed countries are found using FTA as an excuse to export their e-waste in the developing countries (GOI, 2014). Further,

From the above analysis, a dilemma for the development strategy is seemed to have emerged as one the one hand export of ICT is important in its growth and hence of the overall growth of the economy; whereas the ICT growth means more import of e-waste back into the country. It is urgently required to have effective policy structure in place to ensure the sustainability of development as its immediate implications for health and environment cannot be ignored for long.

1.4. The Health and Environmental Impact of E-Waste: Issue of Sustainable Development

As mentioned above, new technology in the form of ICT is associated with of myriads of other issues related to health and environmental in the country. In the last ten years following the direction of Supreme Court, though states have enacted a number of laws to control hazardous e-waste but as it is found in many studies that implementation is lacking, barring a few states. Eventually, e-waste has been growing at an annual growth rate of 10 per cent, one of the highest in the world. Given the quantity, composition and management of e-waste, it has posed numerous health and environment problems to our people. Avoidance and minimization of e-waste is imminent in the reduction of GHG-emission which in turn is possible through reuse and recycling (CPCB, 2012). It is also found that reuse and recycling of 40 personal computers may lead to avoidance CO_2 emissions from 2.1 barrels of oil consumed (UNEP, 2014).

In this regard, another important point worth mentioning is that nearly 94 percent of the e-waste management is taking place in the unorganized sector, which largely rely on scientific methods of collections, dismantle and recycle of hazardous waste components found in e-waste hence posing serious health risk to directly to those involved directly, including children and women, and indirectly others living in close vicinity. This is well documented and acknowledged by many studies in India and outside. For instance, in 2007, a MAIT-GTZ study titled 'E-waste Assessment in India-made a quantitative assessment on the generation, disposal and recycling of electronic waste in India', in the informal sector, only 5% of E-waste goes authorized recyclers. The remaining (95%) is either processed by unauthorized recyclers (informal sector) or is resold, or refurbished and resold, or recycled in an unhygienic, unsafe or unscientific manner in urban slums of the country (GOI, 2011). There are only 13 registered dismantler engaged in dismantling of computers and export the dismantled for metal extraction (GOI, 2012). Attero is one among these companies operational in the country. Players in the organized sector often complain that it is hard to compete with their counterparts in the informal sector because they have to incur huge investment when incorporating all rules and regulation; and very often at loss in failing to establish their links in collecting the e-waste from the local players. and working in as per part in the country Efforts are required to be initiated to bring this with the mainstream to ensure recycling economically viable hygienic environment.

Table 3. **E-waste Inventory and recycling in India (2006)**

Item	**Weight (Mt.)**
Domestic generation	3,32,979
Import	50,000
Total	3,82,979
E-Waste (including electrical) available for recycling	1,44,143
E-Waste	19,000 (5% of total)

Source: Central Pollution Control Board (2008)

1.5. E-Waste Rules and the Associated Challenges in India

As mentioned above, given the very nature of ICT product and owing to high and increasing obsolescence rate, it (ICT) led to the generation of the tremendous amount of e-waste. Realizing this, in India, the government has introduced various measures to treat e-waste in scientifically based effective ways. The report titled, ***Guidelines for the Environmentally Sound Management of E-Waste*** , prepared by CPCB on the management and handling of e-waste has proved to a guiding principal for many polices decision undertaken by the government on the issue of the management of e-waste in the country. However, till the ***E-Waste (Management and Handling) Rules, 2011*** came into force, no effective mechanism was in place to address the issue of e-waste management in India. There was a complete lack of any large scale organized e-waste recycling facility in the country. There were only two units functioning (at Chennai and Bangalore), labeled as small scale e-waste, given their scale of operation. It was in only in 2011 the problem was viewed with a broader perspective, and the onus of electronic wastes (e-waste) was on placed on producers. In other words, it was considered as " producers' liability", i.e. it was the responsibility of the producer to manage the associated e-waste of their product in an environmentally sound and effective way. More precisely, personal computer manufacturers and others white goods makers were now required to come up with solution through setting up e-waste collection centers (known as 'take back' systems).

Towards implementation of the E-waste Rules 2011, CPCB is given the responsibility, and to oversee the progress towards this. Similarly, State Pollution Control Boards/Committees are given the responsibility as regulatory agencies in the respective states. Recently, National Green Tribunal (NGT) also has ordered all producers and manufactures of the electrical and electronic equipment in three states to set up collection centres for taking up e-waste. As per Times Of India Report (17 January, 2015), it has asked to set aside 10 percent of the total advertisement expenditure to educate consumers about e-waste management. May 26, 2015, is set as the deadline to comply for this. In sum, the bench called for the strict implementation of EPR embedded in the Act, 2011. Since the rules of 2011 came into being, e-waste management infrastructure is slowly growing in the country. According CPCB, as of February 2014 there are a total of 98 number of registered recyclers and dismantlers having recycling/dismantling capacity of 29,30,57 MTA. With 39 numbers, Karnataka has maximum number of registered recyclers/ dismantlers followed by Tamil Nadu (19), Maharashtra (15) and Uttar Pradesh (11). Others are distributed in the States of Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Madhya Pradesh, Rajasthan, and Uttarakhand. Trade of E-waste is regulated under Hazardous Waste (Management, Handling and Trans-boundary

Movements) Rules, 2008. Under the Rules no permission for import of E-waste has been granted during last three years by the Ministry of Environment and Forests, Government of India. However, permission for export of 10,575 MT of E-waste has been granted for export of e-waste to various countries viz. Belgium, Germany, Japan, Singapore Hong Kong, Sweden, UK and Switzerland (CPCB, 2014).

The interaction with representatives of the state Pollution Control Board points out the fact that authorization of producers, dismantlers and recyclers in the state have been initiated and have received support from the stakeholders. In fact, till April 2014 the Maharashtra state Pollution Control Board has authorized 27 producers in conformance to the E-waste Rules. Some of the manufacturing companies have set up take-back systems and collection centres have been set up in the state. In addition to public notices, the SPCBs have also issued official circular to the bulk consumers and producers enunciating their roles, responsibilities under the E-waste Rules. However, lack of awareness or public knowledge on the issue remains a critical bottleneck in the implementation of the Rules. All countries across the world, have now taken a serous not of the major environmental threat posed by E-waste. International agreement on the movement of E-waste across countries such as the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes was brought into force in 1992. Under it, stringent rules and regulations govern the mobility (import and export) of toxic waste - including E-waste. The Convention aims to minimize the transportation of hazardous waste around the world by making it illegal to export goods without a special agreement. It has 170 members all around the world, including the U.K, Australia and America. However, some countries like U.S.A, Afghanistan and Haiti, have not yet ratified the convention and are therefore making it not illegal to export electronic waste originating in these countries.

Within USA alone 24 of its 50 states have well established legislation in place on e-waste recycling. According to the 'Electronics Take Back Coalition', which covers nearly 65 percent of Americans covered by some e-waste recycling law. Its main thrust is that most participating states have placed the responsibility and cost of recycling on the manufacturer, except California the only state that requires the consumer to pay recycling costs. Out of these 24 states, 16 have implemented a ban on dumping electronic waste in landfill (UNEP, 2013).

As mentioned above, a major chunk of e-waste is contributed by ICT products. ICT, representing a recent technological paradigm in the form of GPT is considered a double edged weapon, given its contribution in total GDP growth and in total e-waste. Therefore, within the benefits associated with managing end-of-life ICT equipment also lies least known implicit challenge it's recycling across the world including India. Government over time has initiated series of policy measures to control and manage e-waste effectively. The recent environmental law focuses not only on the products but also the end-of-pipe pollution through new product design, substance restrictions, energy efficiency, and take-back rule. However, the laws are not free from challenges faced by the industry in this regard, some of which are discussed.

A. **Extended Producers' Responsibility (ERP) systems:** In order to establish the effective ERP, among many, identifying the unbranded and counterfeit products, poses a major challenge. Studies have shown that very often during product repair, original components get replaced with those of other brands (GOI, 2013). Compared to the formal sector, which follows global standards of e-waste management, informal sector is at comparative advantage in terms per units costs in managing end-of-life products.

B. **Transparency in downstream of the recycling industry:** Another set of problems being witnessed is the lack of technical know-how right from establishing a collection center of recyclable e-waste to scientifically-proven environmentally sound e-waste management. Regarding ICT products such as desktop, laptops or mobile phones, managers are often concerned where exactly these products end up after disposal. It is generally found that ICT companies when selling their ICT scrap through auction often mixed them with other scraps like plastic, steel, etc. ICT industry has therefore limited control over the entire downstream flow of hazardous e-waste. Lack of transparency also poses risks to data security. Many organizations often fear while discarding hard drives or and other data-storage devices (NPCB, 2011).

C. **Limited success of take-back policies:** In the ICT sector, no doubt, while several companies have initiated take-back schemes, green boxes, and collection centers, but these initiatives have however met little or no success. It is therefore imperative to incentivize the adoption of these schemes by making partnership of industries with waste-recycling companies; and other waste generators and handlers of paper, plastic, glass, metal, etc.

2. Conclusion

From the above analysis, what becomes evident is that in India beneath the rosy picture of unprecedented high growth of ICT sector lies a burgeoning problem of e-waste in the country. ICT products such as T.V. desktop, laptop or mobile phones contain valuables resources such as gold, silver or platinum, at the same time are the carrier of many hazardous substances like lead, mercury or arsenic, which eventually of myriad of health and environment damage at large. ICT representing the latest technological paradigm is thus regarded a double edged weapon. Also, in the last couple of decades, i.e. ever since the new investment and trade policies that acted as a catalyst to ICT sector grow has also resulted in massive import of e-waste, which in the last decade has risen many folds. Owning to these factors, the linkages between ICT and e-waste has assumed a multi-dimensional nature.

Given this, ironically, for long, India lacked a well-defined structure of rules addressing the problem of e-waste associated with ICT products. In other words, till the enactment of the ***E-Waste Management and Handling Act, 2011***, e-waste was viewed narrowly, be it the definition of e-waste or about fixing the responsivity in its downstream management. Taking cognizance these inherent weaknesses in the existing mechanism, the Act was formulated with broader perspective encompassing all possible socio-economic or political implications. In the law, though ERP responsibility was fixed on producer of electrical and electronic equipment for e-waste management of all electronics equipment (incusing ICT produces) after its 'end of life', thus the producer is responsible for their products once the consumer discards them. In addition to this, under the EPR, producer is also entrusted with the responsibility to finance and organize a system to meet the costs involved in complying with EPR. As far as the scope of the EPR for the producers is concerned they may estimate/assess their individual requirement and hence can design accordingly a collection centers to take back the product as they deem appropriate in an environmentally sound manner. According to UNEP, 2015, without sustainable management, monitoring and good governance of e-waste, illegal activities may only increase, undermining attempts to protect health and the environment, as well as to generate legitimate employment. Still, a major chunk of e-waste collection, dismantling, and re-cycling is the taking place in the un-organized sector. Those involved, in the pursuit of maximizing return, resort to cost effective unscientific measures in e-waste management eventually resulting in large scale risks to health and environment. Bringing these stake-holders in the mainstream of e-waste management is a daunting task to the government.

References

[1] Economic Survey, (2012-14). Government of India, India.

[2] C.Krger et al, *E-waste Recycling in India: Bridging the Gap between the Informal & Formal sector*, International Solid Waste Association, World Congress 2010, Hamburg, Germany (2010).

[3] V.Khattar, J.Kaur, A.Chaturvedi and R.Arora, *E-Waste Assessment in India: Specific focus on Delhi:A Quantitative Understanding of Generation*, Disposal & Recycling of Electronic Waste, November, (2007).

[4] P.Kumar and Anita, *ICT and Its Development in India*, International Journal of IT, Engineering and Applied Science Research, 3(2)(2014), 2319-4413. . .

[5] P.Kumar and Anita, *ICT and E-Waste in India*, International Journal of Mechanical Engineering and Information Technology, 03(06)(2015), 131-1345.

[6] Central Pollution Control Board, *Implementation of E-Waste Rules 2011 Guidelines*, Ministry of Environment and Forest, Government of India, Delhi, (2011).

[7] A.Mitra, *Electronic Waste Management-Indian Context*, International Journal of Management, IT and Engineering, 13(2013), 358-366.

[8] United Nations Environmental Programs, *Basel Conference Addresses Electronic Wastes Challenge*, Press Release, (2006).

[9] Rajya Sabha Secretariat, *Report on E-waste in India*, India, (2011).

[10] S.Sthiannopkao et al, *Handling E-waste in developed and developing countries: Initiatives, practices, and consequences*, Science of the Total Environment, (2013), 463-464.

[11] Shobana Ramesh and Kurian Joseph, *Electronic waste generation and management in an Indian city*, Journal of Indian Association for Environmental Management, 33(2)(2006), 100-105.

[12] S.Sinha, *Dark shadows of digitization on Indian horizon. In Johri, R., ed. E-waste: Implications, regulations, and management in India*. The Tata Energy and Resource Institute (TERI), (2008), 23-44.

[13] Skinner, Alexendra, at al, *Project Report, Does the Basel Ban form an effective and sustainable means of addressing the health and environmental problems caused by the export of e-waste from developed countries to developing nations and countries in transition ?*, University of Berlin, (2010).

[14] Toxics Link, *E-Waste in Chennai: Time is Running Out*, (2004).

[15] UNEP, *Alert Bulletin, E-Waste: The Hidden Side of IT Equipment Manufacturing and Use*, (2005).

[16] UNEP, *Waste Crime-Waste Risk: Gaps in Meeting the Global Waste Challenge*, (2015).